THURSDAY, OCTOBER 5, 1893.

THE STUDY OF DIATOMS.

An Introduction to the Study of the Diatomaceæ. By Frederick Wm. Mills, F.R.M.S. With a Bibliography by Julien Deby, F.R.M.S. (London and Washington: Iliffe and Son, 1893.)

FEW forms in the organic world have been the subjects of such close, constant and varied study as the Diatoms. Their minuteness, their exquisite modes of growth, development and multiplication in the living state, and the beautiful refinement of symmetry and delicacy of surface chasing in their dead siliceous remains, have made them the special objects of interest, admiration, and often of serious study and research from certainly the dawn of this century until now. But there are few studies of living objects, at least of those that are extremely minute, that show more clearly that the real difficulties presented by them are understood only by those who thoroughly study them. It is the expert who knows how little is known concerning this most interesting if lowly group.

If no other purpose were served by this book, it would in a popular manner make this manifest.

There can be no serious doubt that much of the value that will attach to it as an "Introduction" is due to the very accessible and useful form in which Mr. Julien Deby's "Bibliography relating to Diatomology" has been presented to the student. The work consists of 240 pages; of these only forty-two are devoted to an exposition of the nature and habits of the Diatoms proper. There are three chapters relating to the collecting, the mounting, and the microscopical examination of these forms; but the forty-two pages are supposed to tell us all of importance that is known concerning these beautiful Algæ. Yet the Bibliography is enormous and includes the work and judgments of some of the leading naturalists of our century.

As this volume only aims at being an "introduction" to the study of these organisms, we have no right to anticipate exhaustive treatment in any branch of the subject; but we do not hesitate to affirm that the aim of its author would have been more efficiently reached had certain parts of his subject received a more liberal treatment.

No doubt the Bibliography opens to the amateur and the student almost every channel of knowledge, and will prevent him from attempting to repeat work already done, or from exhausting himself on work that it is at present more or less vain to attempt. But it would have been a great advantage to have seen in a concise form much that has been done in recent years.

Thus we find less than three pages devoted to the "Structure" of Diatoms; what is said is interesting and accurate; but, even remembering the aim of the author, we cannot consider it sufficient. It is quite true that no great generalisation of diatom structure has been arrived at; and we venture to think that much time and patient labour must be spent before it will be; nevertheless, during the last ten years some admirable glimpses at the wonderful architecture of these minute siliceous frustules have been obtained, showing that these silicified cases are not merely formed of two symmetrical valves united to one another by means of two embracing rings which constitute the connecting zone or girdle, and making together an elegantly carved box in which the species may be reproduced, but showing also that the most complete structural principles are embodied in their internal and external construction.

These are certainly not complete studies; but they do exactly what the zealous amateur wants: show the paths along which profitable study may be pursued.

This will apply with even greater force to the almost new branch of diatom work done in regard to "secondary structure" in the siliceous frustule. To those for whom this Introduction could be alone intended, few things could have a larger interest than this.

The nature of the extremely delicate "markings" of diatoms has been so zealously pursued by amateurs and microscopists generally, that it has brought upon them the frequently merited reproach of "Diatomaniacs." None the less it will be by the study of the perforations and physical constitution of the siliceous frustules that we shall ultimately obtain a true knowledge of their modes of motion, and even some aspects of their physiology. It would hardly have been supposed by those who wholly neglect, or even despise the study of the "markings" of diatoms that the wonderful "secondary structure" now demonstrated in many of these frustules had any existence. It may now, however, be taken for granted that every efficient manipulator possessed of a good microscope has demonstrated that, *e.g.*, *Coscinodiscus asteromphalus* is not only covered on its valves with the beautiful areolæ so long and so well known, but that these areolæ are in their turn delicately areolated. The coarse areolations so long familiar to us are for the most part approximately circular in outline; but inside these is a most delicately perforated membrane; and that this is related to the functions of the diatom there can be but little doubt.

Again it may be stated that these studies are incomplete; that is so; and, moreover, they require good instruments, and good manipulation of them, for satisfactory results; but we believe that it is such matters that the leisured amateur and the young student are most desirous of knowing in order to find suitable lines for profitable study.

It is true that the very remarkable work of Dr. Flögel on diatom sections, and some of his modes of operation are referred to, but these represent a far higher and more unusual class of research. The most elementary student should know something concerning them, and they are wisely referred to in this volume; but they do not compensate for the absence of efficient reference to the class of work we allude to.

The movement of diatoms receives careful treatment in this treatise; we believe, nevertheless, that more recent results might with profit have been referred to. The subject is in many senses one of the most difficult in the range of Biology. The three principal explanations, viz. endosmatic and exosmatic currents, the pre-

sence of cilia, and the existence of a pseudopodic extrusion of hyaline protoplasm, are carefully given. The author wisely inclines to the last. It is certain that one of the results of the use of apochromatic objectives during the last three or four years has been to enable us to demonstrate that not only are there perforations in the siliceous tests of the diatoms, but that in the raphé of some Naviculæ and kindred forms, there is a "great" perforation, which runs tube-like from the apices of the frustule to the central nodule; and this may be readily seen to lend itself to the pseudopodic extrusion and withdrawal of protoplasm; and we commend the study of the possibility of this to microscopists. Delicate stains may be used that will not immediately destroy the organism, and that will tend to make the "hyaline protoplasm" at least more manifest. But in this connection the work of Bütschli and Lauterborn cannot be neglected, Making *Pinnularia nobilis* the subject of research, they specially directed attention to its mode of motion. The motion in diatoms is of a peculiar kind, being frequently a series of jerks which carry forward the frustule in the direction of its length, and often carry it back along the same path. Yet the motion may be smooth and equable.

Bütschli conceived the idea of placing under the thin covering glass, laid upon the top of the water in which he was microscopically studying the *Pinnularia*, a minute drop of Indian ink. This in its ultimate particles is, of course, not soluble. Its extremely fine granulation was therefore of great value, for by means of the enormous multitude of these black granules he affirms that he was able to see an extremely fine thread, which was directed backwards. This, he contends, was a protoplasmic filament, but so fine, and, as we apprehend, so near in its refractive index to that of water, that it is otherwise invisible.

This filament, it is stated, is formed by jerks, and the diatom was simultaneously moved in the opposite direction; while at times the filament appears to be retracted.

That these results are of value, there can be no doubt, and they open a line of study that may be most profitable.

Mr. Mills has adopted the method of classification for the Diatomaceæ which for the present may fairly be considered the best; but we can but fervently hope that a series of detailed discoveries will at no very distant date make such generalisation possible as will superinduce a great simplification in this direction.

There is a very useful chapter on Mounting Diatoms, and some excellent teaching on the microscopic examination of these forms; and the whole is rendered complete by a chapter that will greatly aid the beginner, on "How to Photograph Diatoms."

We welcome this book; it will occupy a distinct place in the literature of the subject in our language at present, and will, we hope, make the way for a greatly enlarged and amplified second edition. There is much to praise in the volume, and what we have endeavoured to point out as deficiencies we do not treat as defects. The subject is so large that an author may well pause and wonder at what point an "Introduction" to such a subject should halt in details. But we think that what has been given will open the way for very much more, and hope that Mr. Mills may be called upon and induced to provide it.

We note some printer's errors in the book. It will suffice to call attention to page 6, where a period at the end of the second line destroys the sense; to the word 'rhizopodo" for "rhizopodia" on page 13; to the wrong spelling of an author's name, as in the foot-note on page 5, and to a reference to "northern microscopic" for "northern microscopist" on page 159. D.

THE PROPAGATION OF ELECTRIC ENERGY.

Untersuchungen über die Ausbreitung der Electrischen Kraft. Von Dr. Heinrich Hertz. Pp. 295. (Leipzig: Johann Barth.)

A DISCOVERER'S own account of his work is always of interest, and when it is an epoch-making work and the account so clear and well described as to be intelligible to all, it deserves the most careful attention, and should be studied by all who feel any interest in the subject. Dr. Hertz's account of his discovery of the propagation of electric energy is eminently a work of this kind. The subject is of immense importance; the work described is of the highest order of experimental investigation; the results attained have contributed more than any other recent results to revolutionise the view taken by the majority of scientific workers as to the nature of electromagnetic actions. It is to be hoped that a translation of this account of one of the greatest advances in our knowledge of nature will soon be in the hands of all who care to learn how the functions of the ether have been raised from obscurity into light, from being in the opinion of many a pious belief to be the momentous question of the hour. Prof. Hertz gives in his introduction an interesting account of the steps by which Maxwell's theory may be connected with the older theories. These latter supposed action at a distance pure and simple, and postulated two fluids, &c., &c. They neglected the intervening medium. The second step was to introduce the medium as performing some function when it was a material medium, but still to retain the positive and negative electricities acting across the space from molecule to molecule. This was practically Mossotti's theory as to the properties of the dielectric founded on Poisson's theory of magnetic induction. M. Poincaré seems to have got to about this stage, or perhaps a little further. The third stage was to transfer the molecular action to the ether, but still to consider it as due to electrical fluids attracting and repelling one another, producing the etherial stresses. The fourth stage was to see that these attractions and repulsions of electrical fluids are quite superfluous, and to attribute the whole phenomenon to stresses in the ether set up by straining it. In this last stage there is no room for an electrical fluid with attracting and repelling properties, and accordingly it is suppressed. What the structure of the ether may be which is strained, and thereby electromagnetic stresses produced, is still unknown, and consequently the nature of the strain is unknown. It certainly differs from the ordinary straining of a solid in two im-

portant respects. In the first place, the mechanical stresses are proportional to the squares of the quantities that represent the strains; and in the second place, they depend on the absolute strain, and not on the relative displacement of the parts of the medium. Solid structures can be invented that have laws of this kind. The change of longitudinal stress in a stretched string is proportional to the square of the transverse displacement, and, if the ends of the string are fixed, this stress depends on the absolute value of the displacement. Upon a foundation of a somewhat similar kind a theory as to the structure of the ether being like a solid in tension may be founded, which gets over many of the difficulties of the simple elastic solid theory of the ether. We are, however, still a good way off any really satisfactory theory as to the structure of the ether, but the leading idea of Maxwell's theory, that electromagnetic attractions and repulsions are due to some sort of strain in the ether, is the direction in which scientific men are at present seeking for a dynamical explanation of electromagnetism and for a structure of the ether. Prof. Hertz, however, seems content to look upon Maxwell's theory as the series of Maxwell's equations. This is hardly fair. Maxwell has done much more than produce a series of equations that represent electromagnetic actions. Weber and Clausius went very close to that without revolutionising our ideas as to the nature of these actions. Any exposition of Maxwell's theory which does not clearly put before the reader that energy is stored in the ether by stresses working on strains, is a very incomplete representation of Maxwell's theory. The bulk of Prof. Hertz's work is, however, not concerned with any theory, but with the practical study of electromagnetic propagation along conducting wires and throughout space. This is the work for which Prof. Hertz is so justly famous, and on account of which Hertzian oscillators, Hertzian receivers, Hertzian waves have become in the few years since 1888 the objects of universal attention. No physical experiments since those by which Joule founded the theory of the conservation of energy have produced as great an effect on science as these experiments here described by their author. The subject is brought down to last year, and the experiments of others are mentioned and discussed. In this connection it may be worth while remarking that the observation that the waves emitted by a Hertzian oscillator are of all sorts of wave-lengths was clearly stated by Prof. Hertz himself when he explained how rapidly they died out. For what is a rapidly dying out oscillation except a Fourier series of all sorts of waves? There is consequently no essential difference between these two statements. The first states more than the second, for it explains the character of what in the other statement is described by the vague term, "all sorts of waves."

The whole work is most interesting, and well deserves the best attention of all interested in the greatest scientific advance of the last quarter of the nineteenth century, a century that has seen thermodynamics founded by Carnot and Clausius, conservation of energy by Joule, bacteriology by Pasteur, the origin of species by Darwin, and the functions of the ether by Faraday, Maxwell, and Hertz.

OUR BOOK SHELF.

Helps to the Study of the Bible. By Henry Frowde. (London, 1893.)

THE publisher of this useful volume of *Helps* is to be congratulated on the production of a work which is far in advance of any other book of the same kind published in England. It consists of six parts, which comprise a brief history of the Bible and its most ancient versions, including terse remarks on its canon and authenticity; a summary of the contents of the books of the Old and New Testaments; an account of the Apocrypha, together with historical and chronological notices of the period; a series of chapters on the history, geography, geology, botany, zoology and ornithology of the country of Palestine, on the Jewish Calendar, weights, measures, money and time, and on the musical instruments of the Bible; and a concordance, atlas, list of obsolete English words, glossary of antiquities and customs, &c., referred to in the Bible. The book represents the collected learning of many eminent specialists and scholars, arranged in a handy form and most convenient for reference. The evidence relating to Bible history which may be derived from the recently established sciences of Assyriology and Egyptology, is illustrated by a series of beautiful plates, which cannot fail to be appreciated by every thoughtful reader of the Bible, and are worth more for purposes of explanation than many dissertations could ever have been. In the first plate the connection of the Hebrew alphabet with the hieratic writing of Egypt is shown, and from this we are led to the Latin and Greek alphabets and to the Rosetta and Moabite Stones. Facsimiles of the oldest Hebrew and Syriac MSS. of the Bible are next given, together with specimens of the text of the Vaticanus, Sinaiticus and Alexandrinus codices. The funeral customs of the Egyptians are explained by reproductions from bas-reliefs, papyri, &c., and from the monuments of Assyria and Babylonia a large number of important illustrations have been selected to throw light upon the various occasions upon which the Israelites came in contact with the "great king." The busts of the Roman emperors referred to in the New Testament, and the Temple of Diana, are the subjects of the plates inserted to illustrate the New Testament. At the foot of each plate is a brief description, which, we must hope, may in some cases be lengthened in future editions of this excellent book.

Differential Calculus for Beginners. By Joseph Edwards, M.A. (Macmillan and Co., 1893.)

MR. EDWARDS has put together in a handy form for schoolboys the elementary parts of his large treatise on the Differential Calculus. The subject is here presented in a clear and interesting manner for beginners, and it is to be hoped that the book will be useful in leading to a more general study of this indispensable subject than has hitherto been customary in this country.

The French schoolboy learns the elementary ideas as part of his Algebra, but with us it has been thought right that "calculus dodging" should precede the study of the calculus itself, under a mistaken application of the proverb—*Principiis enim cognitis, multo facilius extrema intelligetis.*

Geometrical applications are very judiciously introduced at an early stage, but considering that the first differential coefficient invented was for the expression of a Velocity, these applications would be rendered more instructive by the introduction of the notion of Time as the primary independent variable.

But "this is Dynamics" the schoolmaster will say, and so must be kept separate by a sort of water-tight bulkhead. G.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Thieving of Assyrian Antiquities.

1. HAD I known that after having dissected my reply to the article entitled "Thieving of Assyrian Antiquities," which appeared in NATURE of the 10th ultimo, you had intended to add further objectionable remarks to it, I should have certainly declined to have had it published.

2. You seem, even now, to ignore the judgment of the High Court of Justice in the slander case of "Rassam *v.* Budge," and volunteer your own version of the story with which you have been supplied.

3. May I ask where you have found it reported about the evidence of the British Museum accountant and Sir Henry Rawlinson's deposition regarding the fragments of the national collection? If you have obtained your information from the latter's deposition that was certainly not revealed in the Press, and if it was supplied you by men who had no business to do so, then in fairness you ought to have quoted the other parts of the evidence. As for the "accountant," no paper reported what the Principal Librarian wanted him to say, and that was for a very good reason, because the Judge did not consider his evidence of any use, seeing that no one had disputed the purchase by the authorities of the British Museum, of Babylonian antiquities before I began my researches in Southern Mesopotamia, at the time when I was there and afterwards.

4. With regard to the cock-and-bull story about the basreliefs which are alleged to be at "Comford Hall," if you had said in your article, above referred to, that they *existed* in a private house in England, *instead of asserting that they were obtained by purchase*, I would have surprised you with further revelations that such "slabs" do exist in other houses in England and in different parts of Europe and America. Even half of the sculptures I had discovered in Assur-beni-pal's palace in 1853, belonging *legitimately* to the national collection, have been squandered, and part of them are now in the bottom of the Tigris.

5. As you seem to have allowed yourself to be imposed upon by malicious men who are not brave enough to put their names to the information with which they have supplied you, I must now close my correspondence, as it seems to me that your journal is not a proper channel through which justice can be obtained.

H. RASSAM.

6, Gloucester-walk, Kensington, W. September 23.

[THE above letter calls for some additional "remarks." We trust Mr. Rassam will find them less "objectionable" than the former ones.

1. The dissection to which reference is made consisted only of omissions of personal attacks, not even courteously worded, which moreover had nothing to do with the question of importance to the public.

2. Mr. Rassam is not happy here in his expressions. Nothing was stated in our article which was not openly stated in Court.

3. He is still less happy here. In his last letter he wished to make our readers believe that Sir H. Rawlinson's opinion on the "rubbish" Mr. Rassam had sent home was not stated in Court, and had been obtained by us in some improper way from the British Museum. In our "objectionable remarks" we charitably suggested that he had *forgotten* Sir H. Rawlinson's deposition containing this opinion was read in Court. It now seems that Mr. Rassam had not forgotten it in the least.

With regard to the accountant; the counsel for the defendant did say what the accountant was to prove, and the Editor does not see what the Principal Librarian had to do with it.

4. Why does Mr. Rassam take the trouble to misquote us by writing "Comford" instead of "Canford," and then to put his misquotation in inverted commas? The "story of a cock and bull," which we took from one edition of Murray's Guide is repeated in more detail in a later one, and even the name of the donor is mentioned, Sir A. H. Layard.

The more "revelations" Mr. Rassam can supply; the more he can show that property "belonging *legitimately* (the italics are Mr. Rassam's) to the national collection" has been squandered; the more reason there is for the inquiry to which we have pointed.

5. Requires no comment except that not a single inaccuracy on our part has been established.—ED. NATURE.]

Vectors and Quaternions.

I WISH to make some observations in reply to the letter of Prof. Knott which appeared in NATURE (June 15, p. 148). For my part I have nowhere condemned the system of Hamilton and Tait as "unnatural" and "weak"; on the contrary, I have always spoken of it with respect and admiration. To appreciate its value and high place in analysis it is not necessary to be blind to its imperfections and limitations. As to whether my work is mere innovation and a recasting of quaternion investigations, I leave to the judgment of those who read my papers. I wish merely to remark that Prof. Knott says nothing about exponentials, and that he has not pointed out what quaternion investigations are recast in my paper on "The Fundamental Theorems of Analysis Generalised for Space." It is the duty of a critic to state correctly and fully the principles which he criticises; this has not been done; my position has been misrepresented. It may aid the scientific discussion of this matter if I state briefly the principal positions I have taken, and the replies that have been given.

I have said that the quaternion notation can be improved. As regards notation, Hamilton himself was an innovator, and in his writings he apologises for the introduction of the strange symbols S, V, T, K, U, I, &c. My aim has been to generalise as much as possible the notation of ordinary analysis, as it is desirable to have one harmonious algebra, with easy transition from line algebra to plane algebra, and from plane algebra to space algebra. Prof. Tait himself has said in one of the prefaces to his treatise that a revolution in the matter of notation must ultimately come; but I infer from the ecstacy of his admiration, that Prof. Knott considers it part of the original brightness of the Archangel.

I have said that the quaternion definitions are not all that can be wished for; I have pointed out what appear to be defects, and I have attempted to remove them. According to Prof. Knott, "the quaternion originally defined as the quotient of two vectors, can also be represented as the product of two quadrantal versors." I reply that what is wanted is not an original or temporary definition of "quaternion," but one that will stand throughout; that in strains we have a quotient of two vectors which is not a quaternion, but a dyad; that we do not ask for a representation, but a definition; and that the representation indicated involves the idea of a versor, which, leaving out a mere multiplier, is the very thing to be defined. Further, the following questions may be asked: If by a quaternion is meant the quotient of two vectors, how can the product of two vectors be a quaternion? We have also the nice distinction that a quaternion may be represented by the product, but not by the quotient, of two quadrantal versors. It is certain that the product and the quotient of two quadrantal versors are quantities of the same kind; if the one is a quaternion, so is the other.

I have said that some of the fundamental principles of quaternions require to be corrected, especially the one which identifies versors with vectors. I have said that if α denote a unit-vector, then $\alpha^2 = 1$, not $= -1$. It is not a bare assertion that "to my mind" it appears so; a reason is given. Let a body of mass, m, have at any time a linear velocity whose rectangular components are a along the axis of i, b along j, and c along k; the kinetic energy of the body is $\frac{1}{2}m(ai + bj + ck)^2$, that is, $\frac{1}{2}m(a^2 + b^2 + c^2)$, not as quaternionists would have it, $-\frac{1}{2}m(a^2 + b^2 + c^2)$. The convention involved is one that pervades the whole of analysis, namely, that the product of two lines having the same direction is positive, while the product of two lines having opposite directions is negative. As kinetic energy is a square, the two lines must always have the same direction.

I have said that if $\alpha^{\frac{\pi}{2}}$ denote a quadrantal versor, then $\left(\alpha^{\frac{\pi}{2}}\right)^2 = \alpha^{\pi} = -1$, and that Hamilton's rules apply to versors, not to vectors. Prof. Knott says that I advocate a system which loses the associative principle and gains nothing but a positive sign and an undesirable complexity in transforming by permutations. Readers of NATURE will be surprised to learn

that I advocate nothing of the sort. What I do advocate is to treat vectors as vectors, and versors as versors, and I show that the products of versors differ essentially from the products of vectors in that the associative rule applies to the former, but not to the latter. Prof. Knott justifies the treatment of quadrantal versors as vectors, because they are compounded according to the parallelogram law. It is true that the components of a quadrantal versor are so compounded, because every versor involves an axis; but the minus comes in, not on account of the axis, but on account of the angle of the versor, the very element which differentiates it from a vector.

I have said that $\nabla^2 = \frac{d^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2}$ is more consistent with analysis than $\nabla^2 = -\left(\frac{d^2}{dx^2} + \frac{d^2}{dy^2} + \frac{d^2}{dz^2}\right)$, and I have remarked that in works on mathematical physics, even in Kelvin and Tait's "Natural Philosophy," the minus was dropped. A sign that can be so readily dropped has probably got no good reason for its appearance. In reply, Prof. Knott says that "when $\nabla^2 v$ occurs in ordinary non-quaternion analysis, it is used in the sense of the *tensor*, for only as such can it come in." This explanation does not explain; for "the name *tensor* is applied to the *positive* number which represents the length of a line" ("Hamilton's Elements," p. 164). Now the ordinary analysis is not limited to signless quantities, but embraces quantities which may be positive or negative. Why then is the minus dropped in an analysis where sign is essential? I asked for a proof of the principle that $\nabla(\nabla\omega) = \nabla^2\omega$; it is replied that "in quaternions there is no doubt whatever." Are we permitted, then, to doubt it as a truth in ordinary analysis, being true only in quaternions? If it is a matter of convention, no one desires two contradictory systems of analysis; if it is a matter of truth, it cannot be true "in quaternions" and not in ordinary analysis.

I have said that the rule $ij = k$ expresses what is true in space of three dimensions. Prof. Knott asks: "If a vector cannot be a versor in product combinations, what is the signification of the equation $ij = k$?" Let us first of all remove every ambiguity from the equation. We have then in all three cases: first, i and j both quadrantal versors; second, i a versor and j a vector; third, i and j both vectors. To distinguish between a quadrantal versor and a vector, let the former be denoted by $\overset{\pi}{i}$. Then $\overset{\pi}{i}\overset{\pi}{j} = -\overset{\pi}{k}$ means the forward order being taken, that a quadrant round i followed by a qudrant round j is equivalent to a quadrant round the opposite of k.

Again, $\overset{\pi}{i}j = k$ means that the vector j, when turned through a quadrant round i coincides with k. Finally, ij means the unit of directed area which has i for base and j for altitude; for some purposes it may be represented by k on the principle that the axis of a plane may be specified by the axis which it wants; but at p. 92 of "The Principles of the Algebra of Physics," I have shown that the several types of products of vectors may be formed independently of that principle. Prof. Knott states that he fails to see what physical considerations have to do with mathematics of the fourth dimension. It is evident, however, that his perception cannot be taken as a criterion of truth, for every type of product of four vectors is geometrically real excepting the one which supposes them all independent of one another.

I have said that the rules for differentiation are much simplified when vectors and versors are not confounded. In proof of this I invite comparison.

I have said that the principles of quaternions can be greatly extended. In my papers will be found for the first time the extension of space analysis to logmarithmic spirals and to hyperbolic trigonometry. The connection of the latter with non-euclidean geometry is also pointed out. As further evidence of the fruitfulness of my notation and principles I may mention that I have just read before the Mathematical Congress assembled at Chicago two papers—one on "The Definitions of the Trigonometric Functions," the other on "The Principles of Elliptic and Hyperbolic Analysis." These papers give the trigonometry of the elliptic and hyperbolic surfaces.

As regards Prof. Knott's closing quotation from "Paradise Lost," I feel like the Senior Wrangler who, having read through the poem, remarked that it was all very pretty, but he didn't quite see what it proved. I close with a quotation which is from as good a book, and possesses more logical force: "Ye shall know them by their fruits. Do men gather grapes of thorns, or figs of thistles?" ALEXANDER MACFARLANE.

Chicago, Ill., August 26.

Astronomical Photography.

THE letter from Lord Rayleigh in your issue of August 24, on the subject of "Astronomical Photography," will, it is to be hoped, elicit some information from photographic experts.

Meanwhile, accepting what Lord Rayleigh says as to the present possibilities in the preparation of plates, I fail to see where any considerable saving is to be effected in the cost of the apparatus, as he appears to suggest.

For astronomical photography a pair of telescopes are required. The larger of these is employed to take the photographs, and the smaller acts as a guider. Supposing that plates could be obtained which were acted upon by visual rays, while comparatively insensible to the violet and ultra-violet light, this would simply mean that both the objectives would have to be made visually perfect, instead of having one of them as heretofore corrected for violet and ultra-violet light. A photographic objective is no more costly than a visual one of the same aperture; and as to mounting clockwork and dome, there could be no difference in expense.

Of course, if the necessity for a separate guiding telescope could be avoided by the adoption of Lord Rayleigh's suggestion, there would in general be some saving of expense; it should, however, be noted, that even when reflectors are employed for taking the photographs, it has not been always found desirable to dispense with the guiding telescope, though in this case, of course, the question as to the nature of the plates cannot arise at all.

In the particular instance of the instrument now proposed for Cambridge, the guiding telescope is already to hand in the shape of the present Northumberland instrument.

It is certainly easier to test the qualities of an objective corrected for visual rays than for photographic rays (if I may still use language which Lord Rayleigh has pointed out as incorrect). On this account it would, therefore, be desirable to have plates such as he refers to, rendered available for astronomers engaged in photographic work. ROBERT S. BALL.

Observatory, Cambridge, September 12.

P.S.—Sir Gabriel Stokes, after reading the above, writes: "I would ask whether in an orthochromatic plate the blue and violet are impressed more feebly than the rays which are visually the brightest. It may be so, but I do not happen to know whether it is."

The Constellations of the Far East.

WITH regard to the questions asked by "M. A. B." about the grouping of stars into constellations (NATURE, August 17), I venture to answer the last two, which the limited knowledge of an Oriental may partly meet, hoping thereby to interest some of your readers.

I do not consider that each race necessarily relies on its own plan in the fabrication of constellations. The Coreans and Anamese are said to be still adhering to the Chinese system, and till lately the Japanese were doing so. It is strange to find the latter, replete with so peculiar mythology, on which the national claim for high ancestry rests, possessing very few vernacular constellations.

Undoubtedly the Chinese system is of peculiar aspect. A name is given to a "Seat," which is sometimes a single star, but in general a group of stars, varying in number from two to twenty or thirty; and in one group, the Imperial Bodyguards, they amount to forty-five. Occasionally the same stars are at once named collectively and individually; thus, the first seven stars of Ursa Major are grouped into Peh-tau or the North Ladle, of which the scoop consists of Shu α, Siuen β, Ki γ, and Kiuen δ, and the handle of Yuh-hang ϵ, Kai-yang ζ, and Yau-Kwang η. With Polaris as the centre, the heavens are radiantly divided into the twenty-eight "Inns" of unequal breadths, each division being denominated after its typical constellation, besides enclosing numerous Seats subordinate to the latter.

The fundamental idea of the plan is enigmatically expressed thus: "Sing (the star) is Tsing (the spirit)." Its solution con-

tinues: "Its body grows on the earth, and its spirit is perfected in the heavens." Consequently, various worldly facts and acts that have occupied the Chinese attention, not excepting some now quite forgotten, remind us of their past existence by means of the stellar and constellar names fashioned after them from fancied resemblances or analogies.

How closely this association of the heavenly and worldly phenomena was made, a few examples will suffice to show. The Bow-and-Arrow, though apparently separate, formed but one group, because an archer could perform well without an assistant; but, on account of the supposed impossibility of one's pounding, without an attendant to the mortar, the Mortar was distinct from the Pestle. Imitating the civil institutions of old times, Polaris, entitled the Emperor of Emperors, and his Empress, Imperial Heir, &c., constitute "Ché-wi Palace," with thirty-two subservient Seats, mostly named after officials. Besides, the four "Imperial Thrones" are established, one of which is surrounded with seventeen dependents, chiefly with the names of court-buildings in "Tai-wi Palace," while the other, amidst the "Celestial Emporium" has its seventeen subjects, named after provinces, market buildings, and measures.

For contriving the applications of the plan, the following methods seem to have been observed:

(1) Number, *e.g.* the Five Princes, Four Councillors.

(2) Magnitude, *e.g.* the Squire Captain, set apart from the Squires.

(3) Form, *e.g.* the Canopy, Celestial Coin, Ascending Serpent.

(4) Relation of positions, *e.g.* the Deep Water, Celestial Hook, and Celestial Pier, entirely and partly in, and along the Celestial River (the milky-way).

(5) Direction of the Compass, *e.g.* the South Gate, North Pole.

(6) Colour, *e.g.* Excrementum.

The objects and attributes resorted to for modelling the stars and constellations may be classified as follows:—

(1) Heavenly Bodies, *e.g.* the sun, moon, milky-way.

(2) Meteorological phenomena, *e.g.* thunder and lightning.

(3) Topographical Divisions, *e.g.* the field, tumuli, park, pond.

(4) Civil Divisions, *e.g.* Tsin (a province), Chang-sha (a shire).

(5) Animals, *e.g.* the dog, wolf, fowl, fish, snapping-turtle.

(6) Agricultural Products, *e.g.* bran, hay, gourd, cereals.

(7) Parts of Body, *e.g.* the tongue, penis.

(8) Human Actions, *e.g.* the cry, weep, slander, punishment.

(9) Family Relations, *e.g.* the son, grandson, adult, old man.

(10) Occupations, *e.g.* the farmer, weaving-woman.

(11) Buildings and Departments, *e.g.* the castle, granary, kitchen.

(12) Implements, Furniture, &c, *e.g.* the lock, drum, bell, bed, ship.

(13) Titles and Officials, *e.g.* the feudatory, ministers, generals.

(14) Heroes, *e.g.* Fu-yeh, Tsau-fu.

(15) Philosophical and Theological Notions, *e.g.* positiveness, virtue, prodigy, fates, fortune, wrong, &c.

As far as I could expound, the system implies certain peculiarities. First, it preserves some abstract notions, thus pointing the way towards investigations on the early Chinese speculations. Secondly, portions of the system severally harmonise with the conditions of the Chinese social system that existed for many centuries before the dawn of the Han dynasty (*circa* 200 B.C.), when it seems certain that the nomenclature was well-nigh finished. In the third place, I may mention that after careful revisions of the whole list containing more than three hundred names of the Seats, I have found but two that have had any reference to the sea, viz., "South Sea" and "East Sea," the rather vague notions of old usage indicating some uncivilised territories; and with this only exception there occur no names of marine beings such as Cetus, Delphinus, and Cancer. This fact probably justifies a historical theory that locates the cradle of Chinese civilisation on a land distant from the seas.

I do not know precisely what system is current among the Indians of the present day; but assuredly at least once they made use of their own plans, and mapped out the heavens into the twenty-eight divisions, each division with its typical constellations and their subordinates, as is often alluded to in the Buddhist writings of the North. The equality of number of the divisions in the Chinese and Indian systems is striking; but evidence favours the belief in their sporadic growths and analogous development. The Chinese records of the typical constellations date farther back than the epoch of their intercourse with the Indians; in fact, the Indian constellations, as is obvious from their mythic apotheoses and the articles of sacrifice, including such abomination to the Buddhist as blood and bird's-flesh, are essentially of Brahmanical type, and thus proclaim their priority in existence to the event of the Buddhist mission to China, which marks the era of the mutual acquaintance of the two nations.

When we see in the old Chinese works on Indian names, those of the Indian typical constellations, such as Rivata, Kamphilla, &c., not literally interpreted, but merely identified with those of the Chinese, such as Shi, Fang, &c., every two divisions of corresponding order seem to have had extents almost coinciding in the two systems.

Twan Chin-shi (*circa* 800 A.D.), a Chinese Pliny, in his "Miscellanies" has left us an extract from Indian records, registering the objects with which the Indians used to associate the forms of some typical constellations of their own. Of the Chinese typical constellations, the original resemblances or analogies can still be traced, through their names and characters, with the help of the descriptive remarks in cases of difficulty. Replying upon these authorities, I will now proceed to compare the cited objects of alleged resemblances or analogies, in order to see whether and how the fancies of the two nations converge into or diverge from one another, in the establishment of one most conspicuous, and thence typical constellation, out of the stars scattered over a division almost identical in the two systems.

Chinese names.	Remarks.	Objects of Indian fancy.
1. Niu (Taurus).	The bull with horns.	The head of a bull.
2. Wĕi (the Tail).		The tail of scorpion.
3. Liŭ (the Willow).	Curved, with a tip bent, like the willow (twig). ? In Chinese astrology, this is the patron of the snakes.	The serpent.
4. Wei (the Stomach).	The legs of a vessel for cooking.	Same.
5. Su (the Horn of Scops).		The head of deer (with antlers).
6. Ki (the Winnowing fan).		The horns of cattle.
7. Tsing (the Well).		A footprint.
8. Kwei (the unsettled).	Its character, combined with that for "foot," forms one for "kneeling," and its original hieroglyphic represents "one kneeling": hence it is probably of analogous plan with Hercules (kneeling).	The dimple of woman.
9. Kwèi (the Ghost).	The coffin (with corpse).	The Saint's Breast.
10. Pih (the Handle-net).		A hat.
11. Sing (the Star).	The hook.	The river-bank.
12. Fang (the Screen).		Beads of head-dress.

It appears from the above comparisons that sometimes quite analogous or even identical plans might sporadically grow among distinct nations, probably due to the pronounced readiness to be grouped afforded by the stars of not very different brightness and relatively situated in a manner which at once suggests a definite outline.

In conclusion, I should be inclined to state that the peculiarity, in cases where it exists, can no doubt be of great value to students of sociology, as it may help to some extent towards the attainment of various important discoveries. For instance, a Chinese constellation, Nü, or the Woman, is described as very much simulating Ki, or the Winnowing Fan; and this might be closely connected with the frequent occurrence in Chinese works of a figurative phrase, "to serve the fan and broom" in the sense of "getting married." On the other hand, as to the merit of its use for ascertaining the race-affinity, my opinion must be somewhat negative, for, while instances are not wanting of such remarkable analogies among such heterogeneous nations as the Chinese and Indians,

the subject is decidedly one of those social acquirements of highly transmissible nature, its present features being more the result of the national intercourse than that of the race-affinity.

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, August 31.

Mr. Love's Treatise on Elasticity.

HAVING now returned to England, I have had an opportunity of examining my paper on wires (Proc. Lond. Math. Soc. vol. xxiii.), and I find that the discrepancy between my results and those given by Mr. Love, on p. 169 of his book, is due to a slip in my own work. On comparing my equations (11 and 15), it will be seen that in the latter equation the term $-\rho(\sigma\rho - \sigma r\cos\theta)^{-1}dw'/d\theta$ has been omitted. The value of w' is correctly given by equation 31, and when the omitted term is inserted in equation 32, the resulting value of g will be found to lead to values of the couples identical with those given by Mr. Love.

As I am strongly of opinion that the best way of constructing a satisfactory theory of shells and wires is to use the method of expansion, coupled with the hypothesis that all stresses which vanish at the surface may be treated (to a certain degree of approximation) as zero throughout the substance of the shell or wire, I am exceedingly glad to find that the apparent discrepancy is due to a small slip in my work, and not to any defect in the principles upon which the investigation is based. The question as to the values of the couples may now be considered to be completely settled.

A. B. BASSET.

September 28.

New Caledonian Pottery.

I AM extremely anxious to be informed on a little matter, and you are my only resource. In the *Journal of the Anthropological Institute*, August, 1893, vol. xxiii. page 90, Mr. J. J. Atkinson describes the making of New Caledonian pottery. The ingenious device of the pebble as a pivot is interesting. But Mr. Atkinson always says *he*. Do the men make pottery in New Caledonia, or is this a case of what the country school teacher termed the men embracing the women?

Washington, September 17. OTIS T. MASON.

SCIENCE IN THE MAGAZINES.

AMONG the articles of scientific interest in the magazines received by us, is one in the *Contemporary Review*, in which Prof. Weismann replies to Mr. Herbert Spencer's attack upon his views as to the distinction in the Metazoa between somatic and reproductive cells, and on the immortality of the latter, and of unicellular organisms. With regard to the experiments that have been made with a view to proving the occurrence of telegony, Prof. Weismann says:—

Herr Lang, of Stuttgart, has for twenty years experimented with dogs, without, however, ascertaining "a single fact that could be made use of for the advancement of the infection theory." Of course, in such a case negative results prove nothing; and the attempt must be made to determine the truth by new experiments. But as hitherto there have been no positive results from the observations that have been made; and as the most competent judges, namely, breeders who have a scientific knowledge, such as Settegast and Nathusius, and the late head of the Prussian Agricultural Station at Halle, Prof. Kühn, spite of their extensive experience in breeding and crossing, have never known a case of telegony, and therefore have great doubt as to its reality; it seems to me that *according to scientific principles, only the conformation of the tradition by methodical investigation, in this case by experiment, could raise telegony to the rank of a fact.*

In "A Note on Panmixia," Dr. Romanes attempts to remove any doubt that may exist in Mr. Spencer's mind as to whether Panmixia is a *vera causa* of degeneration, by showing that there are not excessive *plus* variations of an organ. Mr. Spencer had said, "If there are not excessive *plus* variations, the hypothesis of Panmixia is valid"—*ergo*, accepting Dr. Romanes' proofs, the doctrine is triumphant.

Mr. Robert H. Scott writes on "Weather Forecasts" in the *New Review*. He describes the difficulties that beset the weather prophet on all sides, and the various proposals that have been made for gathering in information which would increase their trustworthiness. Some of the proposals, *e.g.* the mooring of signal-ships in mid-Atlantic, are purely visionary, and intelligence directly received from stations in the United States or Canada is practically useless, for the condition of the atmosphere is constantly changing, and the rates at which storms cross the Atlantic vary considerably. The fact that the storms that visit us pass to the northward of the Azores would render those islands of little use to the Meteorological Office, even if a cable were laid to them; and all anticipations as to the advantages to be derived from mountain observatories remain unfulfilled, according to Mr. Scott. However, an examination of the results of forecasts prepared at 8 p.m. from 1879 to 1891 is fairly satisfactorily. Taking the eleven districts of Great Britain and Ireland, for which forecasts are made, it appears that, during the period mentioned, an average of 45·5 per cent. of the forecasts were entire successes, and 34·8 partial, thus giving a total of 80·3. Of the failures, an average of 6·6 per cent. were total and 13 per cent. partial. England (South) showed the highest rate of fulfilment, viz. 85 per cent., counting entire and partial successes together. "The least successful districts are, in order of their figures, the West of Scotland, the South of Ireland, and then the North of Ireland, and the North-west of England. The least successful forecasts are therefore our exposed west and north-west coasts."

Other articles of a scientific character in the *New Review* are: "Are we Prepared to Resist a Cholera Epidemic?" by Mr. Adolphe Smith, and "The Increase of Cancer," by Mr. H. P. Dunn.

Under the title "Atoms and Sunbeams" Sir Robert Ball gives, in the *Fortnightly Review*, a description of Helmholtz's shrinkage theory of the maintenance of the sun's heat, with particular reference to the "precise *modus operandi* by which, as the active potential energy vanishes, its equivalent in available heat appears."

"Electric Fishes" is the subject of an article by Dr. McKendrick, and in it we find the investigations carried out by Fritsch, Bois-Reymond and Sachs, Burdon-Sanderson, and Gotch explained in an interesting manner. Before describing the minute structure of individual electrical organs the author makes the following remarks:—

About fifty species of fishes have been found to possess electrical organs, but their electrical properties have been studied in detail only in five or six. The best known are various species of *Torpedo* (belonging to the skate family), found in the Mediterranean and Adriatic Seas; the *Gymnotus*, an eel found in the lagoons in the region of the Orinocco, in South America; the *Malapterurus*, the rääsh, or thunderer-fish, of the Arabs, a native of the Nile, the Niger, the Senegal, and other African rivers; and various species of skates (*Raia*) found in our own seas. It is curious that the Nile is rich in electrical fishes, several species of pike-like creatures (*Mormyrus* and *Hyperopisus*) possessing electrical organs the structure of which has been quite recently investigated by Fritsch. The electrical fishes do not belong to any one class or group, and some are found in fresh water, while others inhabit the ocean.

Two distinct types of electrical organs exist. One is closely related in structure to muscle, as found in the torpedo, gymnotus, and skate, while the other presents more of the characters of the structure of a secreting gland, as illustrated by the electric organ of the thunderer-fish. Both types are built up of a vast number of minute, indeed microscopical, elements, and each element is supplied with a nerve fibre. These nerve fibres come from large nerves that originate in the nerve centres—brain, or spinal cord—and in these centres we find special large nerve-cells with which the nerve fibres of the electric organ are connected, and from which they spring. We may, therefore, consider the whole electric apparatus as consisting of three parts: (1) electric centres in the brain or spinal cord; (2) electric nerves passing to the electric organ; and (3) the electric

organ itself. It must not be supposed, however, that the electricity is generated in the electric centres, and that it is conveyed by the electric nerves to the electric organ. On the contrary, it is generated in the electric organ itself, but it is only produced so as to give a "shock" when it is set in action by nervous impulses transmitted to it from the electric centres by the electric nerves.

The *Humanitarian* contains a revised form of the paper on "Cremation" read at the Edinburgh meeting of the British Institute of Public Health by Sir Spencer Wells.

Mr. Geoffrey Winterwood writes on "Mars as a World" in *Good Words*, his article being based in the main upon Camille Flammarion's recent work on Mars and its conditions of habitability. The article is brightened by nine excellent illustrations. "The Cold Meteorite" is the title of a poem by Mr. W. R. Huntingdon in the *Century Magazine*. The meteorite is thus apostrophised:—

"far better 'tis to die
The death that flashes gladness, than alone
In frigid dignity to live on high;
Better in burning sacrifice be thrown
Against the world to perish, than the sky
To circle endlessly, a barren stone."

HYDROPHOBIA STATISTICS FOR 1892 AT THE INSTITUT PASTEUR.

AN account of the anti-rabic vaccinations undertaken last year in the Pasteur Institute in Paris has been recently published (*Annales de l'Institut Pasteur*, vol. vii. p. 335, 1893). From the statistics here given it appears that no less than 1790 persons underwent this treatment during the past year in Paris alone, and that out of these only four subsequently died from rabies. In 600 of these cases the bites were attributed to animals suspected of suffering from hydrophobia at the time, but in all the others the certainty was established by subsequent veterinary examination, as well as by the death from rabies of other animals bitten by the animal in question.

Since the beginning of the Pasteur treatment in 1886, the mortality from bites on the head after treatment is stated as 1.48 per cent., from wounds on the hands 0·55, and 0·24 per cent. from bites on the limbs.

Thus by far the most serious cases are those in which the head is attacked, and it is pointed out how unfortunate is the delay which frequently occurs between the wound and the arrival of the patient for treatment, the interval militating most seriously against the success of the subsequent inoculations.

The following table indicates the nationality of the patients admitted to the Institute during the past year:—

England	26	Russia	1
Belgium	11	Switzerland ...	3
Egypt	12	Holland	14
Spain	14	India	9
Greece	19	France and Algeria	1584
United States ...	1		
Portugal	96		

Algeria is specially mentioned as being amongst those districts from which the largest number of cases are yearly sent to the Institute.

Last year a patient came from Madeira, rabies having been imported for the first time into the island by a dog from Portugal.

A most unusual occurrence is drawn attention to, viz. the death of a patient, a young Englishman, treated in 1887, and who died last year, five years therefore later, of rabies. Such an exceptional case has not been met with since the commencement in 1886 of the anti-rabic inoculations, which up to the present number 12,782.

Taking the average of cases received during the past six years, rabies appears to reach a maximum in the spring and a minimum in the autumn.

NOTES.

THE Harveian Oration will be delivered by Dr. P. H. Pye-Smith, at the Royal College of Physicians, at four o'clock on Wednesday, October 18.

THE vacancy in the Mineralo ical Department of the British Museum, occasioned by the death of Mr. Thomas Davies, has been filled by the appointment by the trustees of Mr. Leonard J. Spencer, of Sidney Sussex College, Cambridge, who gained the first place at the competitive examination.

THROUGH the munificence of Mr. F. Duncane Godman, F.R.S., a botanical exploration of the island of St. Vincent was made by Mr. Herbert H. Smith and Mr. G. W. Smith in 1889 and 1890. The plants then collected, and those from St. Vincent previously in the Kew Herbarium, have now been arranged, and the resulting catalogue constitutes the *Kew Bulletin* for September (No. 81). All the 977 plants collected by the Smiths are included, whether indigenous or naturalised, and, in addition, 179 flowering plants and 24 ferns not collected by them. We read that, "with regard to the general distribution of the indigenous plants, the principal points are the wide geographical range of the majority, and the smallness of the endemic element, conditions that obtain throughout the whole chain of islands from Tobago to the Virgin group, which are in striking contrast to the proportions of the endemic element in Cuba and Jamaica. . . . . The fern vegetation is very rich and varied, and, in relation to the area, far in excess as to number of species to that of New Zealand, which is generally regarded as one of the most highly concentrated

WE learn from the *Pioneer Mail* that Mr. Dallas, Assistant Meteorological Reporter to the Government of India, leaves shortly for Madras, in order to assist the authorities in starting a daily weather report in that Province.

DR. HENRY B. WARD, of Michigan University, has been appointed Associate Professor of Zoology to the University of Nebraska, Lincoln, Nebr.

DR. E. SYMES THOMPSON will lecture upon the voice, at Gresham College, Basinghall Street, on October 10, 11, 12, and 13. The lectures are free to the public, and commence each evening at six o'clock.

A VERY brilliant meteor was seen about 9.45 last night at Leicester (says the *Times* of October 2). It seemed to burst from near the zenith, and proceeded towards the western horizon, increasing very rapidly in brilliancy, until the ground and atmosphere were lit up so that objects in the landscape could be clearly seen at a long distance for several seconds. Mr. H. Cook, of the Birmingham and Midland Institute, says that the meteor was also seen at Neen Sollars, near to Cleobury Mortimer, Salop, at the above-mentioned hour.

DR. O. LOEW, of Münich, well known for his investigations of the nature of protoplasm in connection with Dr. T. Bokorny, has been appointed Professor of Agricultural Chemistry in the University of Tokio, Japan; and Dr. D. Brandis, a fellow of our Royal Society, Professor of Forestry in the University of Bonn.

IN two recent numbers of the *Botanisches Centralblatt* is a detailed account, by Dr. F. v. Kerder, of the Herbaria and Botanical Museums in St. Petersburg. Of these, five in number besides private collections, the richest and most important

are those of the Imperial Academy of Sciences and of the Imperial Botanical Garden.

THE Natural History Society of Danzig has offered a prize of 1000 marks for the best essay on the best means of producing and spreading fungus-epidemics for the destruction of insects injurious to the forests in Western Prussia. The essays must be written in German or French, and are to be sent in before the end of the year 1898.

The numbers of the *Œsterreichische Botanische Zeitung* for August and September contain interesting reports of the botanical excursion of Dr. E. von Halácsy in the Pindus range in Greece, and of that of Dr. J. Bornmüller in Persia. Dr. Bornmüller describes the flora of the neighbourhood of Bushire in March as being especially rich and beautiful.

A SUBTROPICAL botanical laboratory has been established at Eustis, Florida, under the direction of Prof. Swingle. The diseases of fruits belonging to the *Aurantiaceæ* are a special subject of investigation.

THE singular swarms of flies observed by Mr. R. E. Froude at the end of May last, and described by him in these columns (vol. 48, p. 103 and p. 176), have also been seen at Muskegon, Michigan, by Mr. C. D. McLouth. Writing from that city to *Science* of September 15, Mr. McLouth says that on the evening of June 26 the fire brigade was called to two of the highest buildings, the alarms being caused by an appearance as of smoke issuing from the pinnacles of the towers. In both cases the appearance was found to be caused by clouds of insects. Some insects afterwards captured and supposed to be identical with the swarmers were found to be Neuropters.

THE fiftieth volume of the *Verhandl. des Naturhistor. Vereins der preuss. Rheinlande* contains numerous short notices on various subjects, and three important memoirs:—B. Stürtz, on star-fishes, giving a bibliography of recent and fossil forms, notes on classification and distribution, and descriptions of three new species; a continuation of the monograph, by A. Hosius, on the Foraminifera of the Miocene; and a paper by H. Laspeyres on the nickel ores and minerals of the Rhenish rocks, giving numerous analyses and crystallographic notes.

MR. G. CHRISTIAN HOFFMANN has prepared an excellent catalogue of Section I. of the Museum of the Geological Survey of Canada. It embraces the systematic collection of minerals and the collections of economic minerals and rocks and specimens illustrative of structural geology. Reference is facilitated very considerably by four very full indexes. The first of these is an index to the cases containing the minerals; the second to the numbers borne by the specimens; the third to mining districts, areas, camps, locations and claims, mines, quarries, and pits, and the fourth to subjects. Since all the specimens are from Canadian localities, Mr. Hoffmann's catalogue may be taken as a representation of the mineral resources of the Dominion.

THE modifications in the physiological character of micro-organisms which may be produced by either natural or artificial means, and which may, moreover, become inherited and permanent, is one of the most fascinating subjects in bacteriology. But it opens up a problem of much importance in the identification of bacteria, for the characteristic appearance may become so modified that its original parentage is with difficulty recognised. In this connection the production of a race of *sporeless* anthrax, endowed with the same virulent properties, resembling also microscopically the original form, is of particular interest. Such "asporogène" anthrax was first produced by Chamberland and Roux, through the addition of small doses of potassium dichromate to broth infected with anthrax-blood. By this means a generation of anthrax bacilli was obtained in which the power of producing spores was permanently destroyed. Since the publication of the above, "asporogène" anthrax has been obtained by other investigators, whilst Lehmann came upon such a variety quite accidentally in an old gelatine culture. Still more recently (*Le Bulletin Méd.* p. 293, 1892), Phisalix has succeeded in producing sporeless anthrax by the continuous and successive cultivation of anthrax bacilli at 42° C. For the original infection the blood of a sheep dead of anthrax was taken, and portions of this culture were transferred to a second culture, and also kept at 42° C., this process being continued for twenty-five generations covering a period of five months. The twelfth generation already yielded a variety incapable of producing spores except on being first passed through the body of a mouse, but the fourteenth generation had established a race permanently incapable of producing spores. These asporogène cultures, however, unlike those of Chamberland and Roux, suffered an attenuation of their virulent properties, and the descendants of the twentieth generation were absolutely harmless as regards animals. The possibility, therefore, of pathogenic microbes losing their virulence, or of harmless saprophytes being trained up to acquire pathogenic properties, is one which must without doubt be taken into consideration; and when we remember that sunshine alone may produce such modifications in the physiological characters of microbes as to permanently deprive certain pigment-producing bacteria of this property, and raise up instead a colourless race (Laurent), the indulgence of this possibility becomes yet more within the bounds of legitimate conception.

THE Meteorological Reporter to the Government of India has published No. 5 of *Cyclone Memoirs*, containing an elaborate and valuable discussion, accompanied by twenty-five plates, of three cyclones in the Bay of Bengal and Arabian Sea during the month of November, 1891. The first storm, called the Port Blair cyclone, originated in the Gulf of Siam on October 29 and 30, and caused great destruction of life and property in the South Andaman Island. It is the first large storm for which there is conclusive evidence that it originated outside the area of the Bay of Bengal, and owing to its rapid recurvature several ships encountered the storm twice; it was probably owing to this that the pilot vessel *Coleroon* foundered. An examination of the storms which have occurred since 1737, shows that not more than three or four of them could possibly have advanced across the Malay Peninsula into the bay. The second storm originated on the 1st and 2nd, between the Maldives and the Travancore coast, and is said to be the most violent that has been experienced in Minicoy for the past quarter of a century. This storm is the more interesting from the fact that exact information is rarely obtained of the birth of such a disturbance in the neighbourhood of the equator. The predominant feature was the excessive amount of rainfall, which was quite as exceptional as the storm itself. The third storm originated in the south-east of the bay, on the 19th and 20th; it was remarkable only for its track, as it advanced by a curved path into Central Burma, instead of to the coast of Madras, as usual. The tracks of this and of the first storm show certain abnormal conditions to have existed during the whole of the month. All the disturbances were generated in the humid south-west monsoon current, and were apparently not due to any mechanical action between two opposite air currents. Mr. Eliot states that rainfall appears to be the dominating factor in all large cyclones in India, and that this or aqueous vapour was the chief agent in determining the origin and motion of the three storms above referred to.

A REMARKABLE case of resuscitation of an optical image is described from personal experience by Prof. T. Vignoli in a paper recently communicated to the *Reale Instituto Lombardo*. On the morning of July 3, after a railway journey in a bright

sun, and two days' walk in a suffocating heat, he happened to be in a room with several other persons, and during conversation looked at a balcony bathed in bright sunlight, but without taking any special interest in it. The balcony was decorated with trellis-work and ivy. Flowering creepers were arranged in vertical columns, each column being crossed below by the iron bars of the balcony, and above by sticks supporting the plants. A cage with birds hung up in the middle. Two days afterwards, very early in the morning, the professor was in bed, but perfectly awake, and in ordinary health, when, to his astonishment, he saw on the ceiling, by the light coming through Venetian blinds of two large windows, an exact reproduction, in all its colours and details, of the balcony referred to. The phenomenon lasted long enough to permit some detailed investigation. On closing the eyes, the image disappeared, to appear again when they were opened. It was unaffected by regarding it with each eye alternately. A finger placed between the eye and the image intercepted it in the same manner as it would any ordinary object; in short, the phenomenon obeyed all the optical laws of vision. And not only was the cage of birds reproduced, but also its swinging motion noticed before. Prof. Vignoli argues that this cannot have been a case of ordinary hallucination, since the latter is unaffected by the opening or closing of the eyes, and is practically limited to occasions of abnormal health or disturbed state of mind. It must be regarded as an outward projection of a recollected image, though the mechanism of this projection does not appear to be well understood by the professor himself. A case such as this, of what the German psychologists would call *wach-traum*, merits the attention of those interested in psycho-physics.

THE current number of the *Electrical Review* contains a description of some of the latest appliances in "electric heating" for domestic use. In the cookery experiments at the Crystal Palace last year the efficiency obtained was, as a rule, very small, and the wires used in the apparatus were soon destroyed. Mr. Binswanger, of the General Electric Company, claims to have got over both these drawbacks, as well as that of the difficulty of insulation. Instead of wrapping the wires in asbestos, mica, &c. (under which conditions they rapidly oxidise), or clothing them with enamel (which cracks at high temperatures), a cement is applied in a cold state, which is said to insulate well without cracking, even at very high temperatures. The "electric kettle" has a copper bottom resting on a double layer of silicate cement, between the two parts of which the copper wires carrying the current are arranged. The 1 pint size takes 3 amperes at 100 volts to raise the water to boiling, and as the time required to raise a pint of water from 15° C. to 100° C. by an expenditure of 1000 watts is 3·7 minutes, this kettle, which is a "300-watt kettle," will take 12 minutes to boil 1 pint. With electricity at 4d. per unit, the cost of boiling the pint of water would be approximately one farthing, which is, of course, much dearer than gas. Stew-pans, ovens, and "radiators" for heating rooms are also made, as well as frying-pans and gridirons, in the two last-named of which greater economy is practicable than in the other cases, as the heat can be produced in the exact spot in which it is wanted. Altogether it is evident that although the use of "electric heating" for domestic culinary purposes is not yet in its really practical stage, it is well on the way there.

IN the course of an interesting series of articles in *Electricité* on the "Electric Lighting of Trains," we find the following figures given as a comparison between the cost of oil-lamps and electric lights. The system under discussion is that of accumulators carried in the train and charged at fixed charging stations. The total expense of an electric-lamp in a first-class carriage, including interest on capital, &c., comes out at 0·0289 francs per "lamp-hour," while an oil-lamp (of only 7-candle power) comes to 0·38 francs per hour, while in the second and third class carriages, where more lamps are run off the same battery, the comparison is still better in favour of the electric system.

A CATALOGUE of works on Phanerogams, alphabetically arranged in genera, has been issued by Messrs. Dulau and Co.

TWO pamphlets by Sir Spencer Wells have been sent to us—one, "The Prevention of Preventible Disease," is a lecture delivered in Glasgow in May last, and the other, "Cremation and Cholera," is reprinted, with additions, from the *Forum* for February, 1893. They both deserve a wide circulation and attentive reading.

MESSRS. CASSELL AND CO. have just published a new edition of "Elementary Lessons with Numerical Examples in Practical Mechanics and Machine Design," by R. G. Blaine. The book has been to a large extent rewritten, and contains a good deal of additional matter, an attempt having been made to bring the work up to date.

THERE is little of scientific value in Mr. Phil Robinson's latest volume—"Some Country Sights and Sounds" (Unwin). The author, however, writes pleasantly enough on a variety of topics more or less to do with the country.

WE have received a volume containing the meteorological observations made at the Adelaide Observatory and other places in South Australia and the northern territory, during the years 1884-5, under the direction of Sir Charles Todd, F.R.S.

A NEW edition (the eighth) of Valentin's "Course of Practical Chemistry, or Qualitative Chemical Analysis," edited and revised by Prof. W. R. Hodgkinson, has just been published by Messrs. J. and A. Churchill. A few additions have been introduced into the work, including an extra chapter, in which quantitative operations are dealt with.

THE June number of *Timehri*, the journal of the Royal Agricultural and Commercial Society of British Guiana, has just appeared, and contains articles on "The Seasons in Guiana," "Notes on a Journey to a Portion of the Cuyuni Gold Mining District," and "Amateur Insect Collecting in British Guiana," occasional notes, reports of the society's meetings, &c. It may be obtained in London from Mr. Stanford.

MESSRS. BLACKIE AND SON have just published an attractive little book entitled "Animal and Plant Life," by the Rev. Theodore Wood. The book is the sixth number of a useful series of science readers adapted for use in elementary schools.

"WEISSMANN'S Theory of Evolution" (1893) is the title of an article by Prof. Romanes in *The Open Court* of September 14. Prof. Weismann's recent modifications of his sequent theory of evolution are the chief points discussed.

A LIST of Coleoptera, prepared by Mr. James Edwards, and forming Part XII. of the "Fauna and Flora of Norfolk," has been reprinted from the Transactions of the Norfolk and Norwich Naturalists' Society (Vol. V.), and issued separately.

UNDER the title "Les Moteurs à Gaz et à Pétrole" (Gauthier Villars), M. Paul Vermand gives an excellent summary of the present state of knowledge of atmospheric motors. The volume belongs to the Aide-Mémoire series. Another work in the same series that has recently been received is "Décoration Céramique au Feu de Moufle," by M. E. Guenez.

MESSRS. METHUEN AND CO.'S Commercial Series, "intended to assist students and young men preparing for a commercial

career, by supplying useful handbooks of a clear and practical character, dealing with those subjects which are absolutely essential in a business life," has received an addition by Mr. H. De B. Gibbins, entitled "British Commerce and Colonies."

A SECOND edition of Mr. J. R. Ainsworth Davis' "Elementary Text-book of Biology" (Messrs. Charles Griffin and Co.) having been called for, the book has been thoroughly revised and much enlarged, and a number of illustrations have been added. Part II. (Animal Morphology and Physiology) has had its value enhanced by the addition of a chapter on the Distribution of Animals.

MESSRS. WHITTAKER'S library of popular science has received an addition in the form of a volume entitled "Electricity and Magnetism," by Mr. S. R. Bottone. The illustrations in the book are a little coarse, but are just what a teacher requires to elucidate the text. Mr. Bottone is evidently at home in his subject, and he knows the way to present it to the general reader.

DR. J. W. GREGORY has conferred a benefit upon students of petrography by translating the "Tables for the Determination of the Rock-Forming Minerals," prepared by Prof. F. Lœwinson-Lessing. The tables of Rossenbach and Michel Lévy and Lacroix leave nothing to be desired in the matter of completeness, but they are of little use to the elementary student for purposes of identification. By means of the synoptical tables, however, the commoner rock-forming minerals can easily be determined when their characters have been microscopically observed. A very suitable introduction to the tables is a description of the petrological microscope, by Prof. Grenville A. J. Cole. Messrs. Macmillan are the publishers of the translation.

THE October number of *Natural Science* is of unusual interest. Among the articles are the following: "The Effect of the Glacial Period on the Fauna and Flora of the British Isles," by G. W. Bulman; "Some Recent Researches on the Habits of Ants, Wasps, and Bees," by George H. Carpenter; and "The Recent Plague of Wasps," by Oswald H. Latter. Dr. C. Herbert Hurst theorises upon "The Digits in a Bird's Wing," and Mr. J. T. Cunningham upon "The Problem of Variation." In addition there are numerous notes and book-notices.

AN investigation of the composition and properties of the dangerously explosive iodide of nitrogen has been carried out by Dr. Szuhay in the laboratory of the University of Buda-Pesth, and an account of his interesting experiments is contributed to the latest publication of the *Berichte*. A large number of investigators have previously attacked this somewhat fascinating subject, but the knowledge hitherto accumulated has been insufficient to enable us to express with certainty its composition. One of its properties, its unparalleled readiness to explode with or without provocation, has been so much to the fore as to almost entirely exclude investigation of its more important, although less sensational, chemical properties. One variety of the substance, which was obtained by Dr. Szuhay by adding ammonium hydrate solution to powdered iodine, was found to be so pre-eminently disposed to detonative decomposition that it frequently exploded even under water, and if it were successfully transferred while wet to a filter it exploded upon the passage of the first draught of air. An attempt to ascertain its composition by careful decomposition with sulphurous acid resulted in the complete pulverisation of the containing vessel. Iodide of nitrogen was first prepared by Curtois by mixing alcoholic solutions of iodine and ammonia. He considered it to be the tri-iodide NI_3, an opinion which was subsequently shared by Gay Lussac. Millon and Marchand afterwards expressed the view, unsupported, however, by experimental evidence, that it contained hydrogen, and might be represented by the formula NH_2I. More recently Bineau, and in this country Dr. Gladstone, have adduced more trustworthy evidence, from its mode of decomposition by an aqueous solution of sulphuretted hydrogen and by sulphurous acid, that this extraordinary substance does indeed contain hydrogen, but only to the extent of one atom, its constitution being NHI_2. Bunsen, however, subsequently communicated to the *Annalen* the view that iodide of nitrogen consists of NI_3, but that according to its mode of preparation it contains more or less ammonia. Finally, Stahlschmiedt has brought forward the further hypothesis that when an alcoholic solution of iodine is mixed with aqueous ammonia the substance NI_3 is produced, but that when alcoholic ammonia is employed the product possesses the composition NHI_2. The result of all this conflicting testimony has been to leave the question of the composition of iodide of nitrogen an open one.

IODIDE of nitrogen was prepared by Dr. Szuhay, after investigating most of the methods hitherto described, by adding excess of aqueous ammonia to a concentrated solution of iodine in potassium iodide. It is thus obtained in the form of a very fine powder, which was found to be capable of safe purification by washing with a dilute solution of sodium sulphate. It is requisite to protect the filter from draughts of air which are liable to induce explosion. The purified substance, of course in a moist condition, as it cannot be dried without explosion, was analysed by decomposition with a solution of sulphurous acid of known strength and estimation of the amount of iodine and ammonia in the solution. Its composition was indubitably proved to be NHI_2, thus confirming the earlier work of Dr. Gladstone and of Bineau. This conclusion is powerfully supported by the fact that Dr. Szuhay has been able to prepare a silver derivative of the compound by replacing the hydrogen atom by silver. This silver compound is readily obtained by adding powdered oxide of silver or an ammoniacal solution of silver nitrate to iodide of nitrogen suspended in water. It is a black flocculent substance which is quite as explosive as iodide of nitrogen itself. When carefully dried the least rise of temperature provokes explosion. It also detonates upon being struck or even when brought into gentle friction with any other substance. When warmed under water, or when treated with dilute acids it is quietly decomposed, silver iodide being deposited, free iodine liberated, and free nitrogen escaping with effervescence. The relative amounts of these products of decomposition conclusively prove the compound to possess the composition Ag_2NI_2. Moreover, considerable evidence is also adduced to show that potassium, sodium, and barium replacement compounds are capable of existence in solution. The existence of the compound HNI_2 is thus fully demonstrated, and whether or not the compounds NI_3 and NH_2I are likewise capable of formation under different experimental conditions is a question which doubtless farther work will elucidate. It is not unworthy of notice that there is a considerable amount of resemblance between this extraordinarily explosive substance and the similarly distinguished azoimide $H-N\langle{}^{N}_{N}\rangle$; for both contain the imido group NH the hydrogen of which is capable of being replaced by silver and other metals, and both appear in consequence to be endowed with a somewhat acid nature by the two atoms of negative iodine in the one case, and the negative diazo-nitrogen group in the other.

NOTES from the Marine Biological Station, Plymouth.—Last week's captures include the Annelids *Myrianida maculata* (one of these with a chain of buds), *Sphærodorum peripatus* and *Siphonostoma uncinatum*, the tubicolous Gephyrean *Phoronis*

hippocrepia, and the Decapod Crustacean *Athanas nitescens*. The floating fauna has presented hardly any appreciable change: numbers of young *Geryonia appendiculata*, some Margelid medusæ and swarms of *Obelia*, have formed the chief Cœlenterate element. *Noctiluca* is generally present in fair quantity. The Ascidian *Ciona intestinalis* is now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Duncan Mackintosh; two Lions (*Felis leo*, ♀ ♀ jew.) from Somaliland, presented by The Lord Delamere; four Long-fronted Gerbilles (*Gerbillus longifrons*) from Tunis, two Long-tailed Field Mice (*Mus sylvaticus*) from France, presented by Mons. Albert de Lautreppe; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. H. Rich; two White Storks (*Ciconia alba*) European, presented by Mr. Walter Winans, F.Z.S.; an Adelaide Parrakeet (*Platycercus adelaidæ*) from Australia, presented by Mrs. Waterhouse; two Common Sheldrakes (*Tadorna vulpanser*) from Scotland, presented by Mr. Francis Alexander; three Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Mr. Henry Beamish; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mr. H. Venn; a Serval (*Felis serval*), a Cape Crowned Crane (*Balearica chrysopelargus*), a Secretary Vulture (*Serpentarius reptilivorus*), a Black-winged Kite (*Elanus cæruleus*) from South Africa, a Grey Squirrel (*Sciurus cinereus*) from North America, deposited; three Viscachas (*Lagostomus trichodactylus*), a Hairy Armadillo (*Dasypus villosus*), two Ypecaha Rails (*Aramides ypecaha*), a Great Grebe (*Æchmophorus major*) from South America, a Prêtrés Amazon (*Chrysotis pretrii*) from Brazil, purchased; four Indian Wild Swine (*Sus cristatus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ON THE PARALLAX OF THE PLANETARY NEBULA B.D. + 41°·4004.—During the summer of 1892 Dr. J. Wilsing began a series of photographs of Webb's planetary nebular B.D. + 41°·4004, using the new photographic refractor of the Potsdam Observatory, with the intention of determining the parallax. In the current number of *Astronomische Nachrichten* (No. 3190) he gives an account of the measurements made. The undertaking seems to have been especially difficult on account of the numerous errors that were liable to arise, and also to the lack of sharpness of the image of the nebula on the photographic plate. From June 1892 to June 1893 he obtained thirty-four plates with two exposures on each of eight minutes duration, and they were all measured with the Repsold's measuring apparatus, a description of which instrument is given in vol. v. of the Publications of the Potsdam Astrophysical Observatory. Six stars were used for comparison, and the distance of the nebula was measured from two of these stars, the others being used for finding the value in seconds of arc of the measured distances, &c. The distances measured show a distinct decrease, as will be gathered from the following table, when N. 3 and N. 6 denotes the distances from the two companion stars respectively:—

1892-93.	N. 3.	N. 6.	Wt.
	′ ″	′ ″	
June 25 ...	7 24·53 ...	13 9 72 ...	3
July 13 ...	24·40 ...	9·77 ..	1
Aug. 8 ...	24·53 ...	9·56 ...	4
Sept. 23 ...	24·42 ...	9·71 ...	3
Oct. 18 ...	24·43 ...	9 61 ...	1
Nov. 10 ...	24·23 ...	9·60 ...	4
Jan. 2 ...	24·32 ...	9·43 ...	4
June 5 ...	7 24·56 ...	13 9 61 ...	3

Assuming the nebula distances from these stars as 7′ 24″·40 + 13′ 9″·60 for 1892·0, the position, corrections, relative yearly proper motions, and the relative parallaxes, when taken into account, gave the following numbers for the equation, observed—calculated

O − C.

N. 3.	N. 6.	N. 3.	N. 6.
″	″	″	″
+ 0·05 ...	+ 0·05	+ 0·06 ...	− 0·05
− 0·07 ...	+ 0·16	− 0·13 ...	+ 0·01
+ 0·08 ...	− 0·11	− 0·05 ...	− 0·08
+ 0·02 ...	+ 0·03	0·00 ...	+ 0·05

The negative relative parallax thus obtained shows, as Dr. Wilsing in his concluding remarks says, that the distance of Webb's nebula from the sun cannot be assumed in any way to be less than the distances of both the eleventh-magnitude comparison stars.

SOLAR AND LUNAR EPHEMERIS FOR TURIN.—In vol. xxviii. of the *R. Accademia delle Scienze di Torino*, Dr. Alberto Manaira contributes the ephemerides of the sun and moon which he has calculated out for the horizon of Torino for the year 1894. For each day of the month throughout the year he gives the time of rising, meridian passage, and setting of the sun and moon. Brief reference is also made to the eclipses visible in that year, giving the time (mean time Rome) of the chief contacts.

GEOGRAPHICAL NOTES.

THE *Mouvement Géographique* publishes a sketch map of Dr. Baumann's exploration to the north-east of Lake Tanganyika, in the country of Urundi. He has traced out the head waters of the Kagera, which take their rise close to Tanganyika and flow down the long slope to the Victoria Nyanza, being thus the ultimate source of the Nile, if it is possible to apply that name to any of the streams which feed Lake Victoria. The mountains between the basin of the Kagera and that of the Rusiji are called by the Warundi *Misozi a Mwedi*, or Mountain of the Moon. Some of the summits were apparently abou 10,000 feet above the sea. The Rusiji River, which flows int Lake Tanganyika at its northern end, is represented provisionall as flowing from the reported Lake Oso, which receives the drainage from the southern slopes of the Mfumbiro mountains, the north slope of which drains to Lake Albert Edward. If this topography turns out to be correct, the Mfumbiro range forms the only barrier across the great meridional furrow which runs from the Mediterranean to the Zambesi, and includes Lakes Albert, Albert Edward, the possible Oso, Tanganyika, and Nyasa.

MR. H. F. B. LYNCH, with his brother and a Swiss guide, succeeded, after seven and a half hours' climbing, in making an ascent of Mount Ararat, on September 19, and promises some interesting information regarding his observations on his return to this country. He took some photographs of the mountain scenery.

PRINCE KRAPOTKIN publishes his address on the Teaching of Physiography, given at the Teachers' Guild Conference at Oxford, in the October number of the *Geographical Journal*. He deprecates the exclusive use of the *Heimatskunde* in introducing children to the study of the earth, and approves rather of teaching geography by considering the earth as a whole, insisting, however, on the importance of personal work by the scholars in their own neighbourhood to extend and give reality to theoretical teaching.

AN interesting history of the mapping of the state of Missouri, by Mr. Arthur Winslow, assisted by Mr. C. F. Marbut, has been published in the Transactions of the Academy o Sciences of Missouri. Starting with the dictum that the civilisation of a people is proportional to the accuracy with which their country is mapped, Mr. Winslow traces the gradual improvement of the maps of Missouri in a readable way. He gives rough sketches of the more interesting early maps. Franquelin's map of 1688 is the first on which the name "Missourils" appears, but the river to which the name was applied is very imperfectly drawn. In Sinex's map of 1710 the position of the Mississippi is shown nearly sixty miles too far west, and the mouth of the Missouri twenty-five miles too far north. In du Pratz' map of 1763 the error in both directions is doubled. Lieutenant Ross, of the British Army, in 1765 made a survey of the Mississippi, accurate as to latitudes, but wrong in longi-

tude. The first really effective survey was that of Messrs. Lewis and Clarke in 1804–1806. In 1815 Land Office surveys were commenced. After the admission of the State to the Union in 1820 more accurate surveys were required to fix the boundary lines, but these had to be rectified in 1850, when serious discrepancies were found. Really trustworthy surveying was only begun when the Coast and Geodetic Survey commenced a triangulated line across the state in 1871. The Mississippi and Missouri River Commissioners subsequently rectified the mapping of the rivers, and now the topographical survey of the State is being carried out by the U.S. Geological Survey, which has executed maps of one-third of the area on the scale of about two miles to the inch. The Missouri Geological Survey also makes a topographical map of selected parts of the State on the scale of about one mile to the inch.

THE OBSERVATORY ON MOUNT BLANC.

AS briefly announced in our Notes last week, Dr. Janssen has recently visited the observatory on Mount Blanc. In the current *Comptes Rendus* he gives an account of the expedition from a scientific point of view, and the following is a translation of his description :—

We left Chamonix on September 8, at 7 a.m., and arrived at the summit on September 11, at 2.30 p.m. The observatory was then in front of us. This construction has several floors, of which the framework, formed by large and massive beams crossed in all directions in order to ensure the rigidity of the whole, produces a deep impression upon the mind. One wonders how it has been possible to transport the edifice to this altitude and fix it on the snow. However, if the conditions offered by the hard, permanent, and little mobile snows of the summit are carefully considered, it is soon recognised that the snows are able to support very considerable weights,[1] and that they will be only slightly amenable to displacements, which will render it necessary to straighten again the construction which has been fixed upon them.

On my arrival I made a rapid survey, and saw that the construction had not been sunk in the snow as much as I had stipulated of the contractors. I do not approve of this. My guides and myself then took possession of the largest underground room. I intended at first to fix the instruments for enabling observations to be commenced immediately, and the provisions were left on the Rocher-Rouge. This circumstance put us in a state of perplexity, for the weather suddenly became very bad, and we had to remain two days separated from the stores. The storm lasted from Tuesday until Thursday morning. Beautiful weather then set in, and I was able to begin the observations.

The observations have for their principal object the question of the presence of oxygen in the solar atmosphere. The Academy knows that I worked at this important point during my ascensions to the Grands-Mulets (3050 metres) in 1888, and at M. Vallot's observatory in 1890.

But the novelty of the observations of 1893 lies in the fact that they have been effected on the very summit of Mount Blanc, and that the instrument employed is infinitely superior to that of the two preceding ascensions. At the first, in fact, a Duboscq spectroscope incapable of separating the B group into distinct lines was employed, while the instrument about to be employed at the summit of Mount Blanc is a grating spectroscope (the dispersive piece of which I owe to the kindness of Rowland), with telescopes having a focal length of 0·75 and showing all the details of the B group. This circumstance is of considerable importance, for it may lead to the discovery, in the constitution of the group in question, of valuable elements for measuring in some way the effects of the diminution of the action of our atmosphere as one ascends into it, and, accordingly, to determine whether this diminution corresponds to total extinction at its limits. In fact we shall learn whether or no the double lines which make up the B group diminish in intensity as their refrangibilities diminish ; that is, as their wave-lengths increase.

This circumstance may perhaps be employed with profit, if not to measure, at least to observe the diminution of the action of the selective absorption of our atmosphere. It has been ascertained that the most feeble doubles fade away one after the other as the atmosphere is ascended, that is to say, as the absorbing action is diminished. Thus, under ordinary circumstances, at the surface of our seas or upon our plains, thirteen or fourteen doubles can be seen, not reckoning that which is known as the head of B.

But even at Chamonix, that is at an altitude of 1050 metres, the thirteenth double is very difficult to make out, and at the Grands Mulets (3050 m.), it is only possible to see from the tenth to the twelfth, while at the summit of Mount Blanc I cou'd hardly go beyond the eighth.

It is not to be supposed that we establish a proportionality between the numerical diminution of the doubles and that of the atmospheric action. The law is evidently of a much more complex character. But this diminution, especially when considered in connection with the experiments made with tubes full of oxygen, and able to reproduce the series of atmospheric phenomena to which we have referred, is sufficient for us to conclude that the B group would totally disappear at the limits of our atmosphere. It is remarkable, however, that if we take the co-efficient 0·566 that represents the diminution of atmospheric action at the summit of Mount Blanc according to barometric pressures $\left(\frac{0{\cdot}43}{0{\cdot}76} = 0{\cdot}566\right)$ and multiply it by thirteen—the number that represents the doubles clearly visible on the plain—we obtain 7·4 as the result ; that is to say, very nearly the number (8) doubles that can be seen by me on the summit of Mount Blanc.

This result is certainly remarkable, but I repeat that, in my opinion, it is only by the comparison with tubes reproducing the same optical conditions as nearly as possible, that any definite conclusions will be obtained. These comparative experiments have already been commenced in the laboratory of Meudon Observatory, and they lead to the same result, viz., the disappearance of the groups A, B, and a at the limits of the atmosphere. On account of the importance of the question, however, the experiments will be repeated and completed.

The question arises as to whether the high temperatures to which solar gases and vapours are subjected are not capable of modifying the power of selective absorption, and particularly whether the absorption of oxygen which takes place in the sun's atmosphere would not be altogether different from that indicated by the experiments which have been made at ordinary temperatures.

I have already instituted experiments with the idea of replying to this objection. I shall give an account of them to the Academy in due course, but I may say that the absorption spectrum of oxygen, either the line spectrum or the unresolvable bands, do not appear to be modified in an appreciable manner when the oxygen is raised to temperatures of about 400 or 500 degrees.

On the whole, I think that observations made on the summit of Mount Blanc give a new and much sounder foundation to the study of the question of the purely telluric origin of the oxygen groups in the solar spectrum, and lead to the conclusions previously stated.

Independently of these observations I have also given some attention to the transparency of the atmosphere of this almost unique station, and to the atmospheric phenomena which are included in such an extensive view, and across such a great thickness. I shall speak of this on a future occasion.

The observatory, of course, is not completed. There yet remains much to be done independently of interior arrangements and the installation of the instruments ; but the great difficulty has been overcome, for we are free to work, and no longer have to reckon with the snowstorms ; the rest will follow in due course.

I hope that the observatory will soon be able to offer a much more comfortable sojourn than I have had there : but that will depend upon the weather. Be this as it may, I regret nothing. I strongly wished to see our work in position, and still more fervently desired to inaugurate it by observations which are ever in my mind. I am fortunate at having been able to realise my desires in spite of some difficulties.

[1] See *Comptes Rendus* for an account of experiments made at Meudon on the resistance of slightly compressed snow.

IRON AND STEEL INSTITUTE.

A VERY successful meeting of the Iron and Steel Institute has just been held in Darlington, commencing on Tuesday, September 26. The President, Mr. E. Windsor Richards, occupied the chair There was a very good list of papers,

eleven in all, as follows:—On the Manufacture of Basic Steel at Witkowitz, by Paul Kupelwieser; on the Waste of Fuel, Past, Present, and Future, in Smelting Ores of Iron, by Sir Lowthian Bell, F.R.S.; on Iron and Steel at the Chicago World's Fair, by H. Bauerman; on Iron and Steel Wire, and the Development of its Manufacture, by J. P. Bedson; on the Sampling of Iron Ore, by T. Clarkson; on the Tudhoe Works of the Weardale Iron and Coal Company, by H. W. Hollis; on the Lührig Coal Washing and Dry Separation Plant at the North Bitchburn Coal Company's Randolph Pit, by James I'Anson; on Carbon in Iron, by Prof. Ledebur (Freiberg); on Suggested Improvements in connection with the Manufacture of Steel Plates, by William Muirhead; on the Last Twenty Years in the Cleveland Mining District, by A. L. Steavenson; on the Production of Wrought Iron in Small Blast Furnaces in India, by T. Turner.

Mr. Kupelwieser's paper was first taken, and gave an interesting account of the basic process, which the author has introduced with considerable success at Witkowitz. It is of course well known that the cheapest process of steel manufacture is that carried out with the Bessemer converter; the Siemens furnace comes next. Although the basic process was originally devised for the use of the Bessemer converter, it has had considerable application with the open-hearth furnaces. The basic process is, however, dearer than the old acid system of manufacture, and some of the most beautiful mild steel produced is made in the open-hearth furnace with a basic lining. The latter, again, is more costly than the old acid lining, and we have therefore the following gradations as to cost:—First, the acid Bessemer, or original process; next, the basic Bessemer; then the acid open-hearth, and finally the basic open-hearth; the latter being the dearest of the four. It is obvious therefore, that when circumstances permit it, that the Bessemer converter should be used in place of the open-hearth, but there is an objection to the Bessemer converter in the fact that it acts so much more quickly; the slower working open-hearth furnace giving time for tests to be made, and the product is consequently more certain. Mr. Kupelwieser has introduced a combined process in Witkowitz, which many members of the Iron and Steel Institute saw in work, when the Institute meeting was held in Austria. The pig-iron obtained in Witkowitz contains too much phosphorus for use in the ordinary Bessemer process, while it does not contain sufficient phosphorus for the basic process. As a further complication, a supply of cheap scrap was not obtainable at the works. The way in which the author got over his difficulties is highly ingenious, and is well worth study by English steel-makers. The pig-iron is run from the blast furnace into the ladle, and transferred immediately to the converter, which has an acid lining. The blast is then turned on, and the blow kept up till the pig-iron is de-siliconised; an operation that requires about five or six minutes to perform. The silicon being removed, manganese and a considerable amount of carbon remain; the metal is poured into a ladle, and taken to the open-hearth furnace, where the process of steel-making is completed. This method of operation has the great advantage that the molten metal, when run into the open-hearth furnace, which is basic lined, does not destroy the lining, as it has become completely de-siliconised. The time required for working the charge is considerably diminished, and the amount of iron taken up by the slag is said to be less, as also are the expenditure of fuel and cost of wages. We do not propose following the author into his figures as to the cost of production, but the balance in favour of his method is 10s. per ton as compared with the cost of conversion in the open-hearth furnace from the commencement, whilst it is said to be no dearer than the basic Bessemer process when carried out on a large scale. Perhaps the chief point of interest to English steel-makers is the working of the metal from the blast furnace direct; a thing which has of course often been considered by steel-makers in all parts of the world. It is always difficult, and often fallacious, to make comparisons unless the whole conditions on both sides be similar, and it is certain that those conditions existing at Witkowitz have not their exact counterpart in this country. It is not surprising, therefore, to find that during the discussion of the paper high authorities differed. Mr. James Riley did not by any means approve of the author's suggestions; basing his objection principally on the waste that would take place in the process. On the other hand, Mr. Snelus and Mr. Whitwell—both high authorities—supported the author. There is of course the undeniable 10s. a ton, which is sufficient vindication of the process as carried out in Witkowitz. Whether the 10s. would still be to the good in English steel works, is a matter that is open to question.

Sir Lowthian Bell next read a paper on the waste of heat, past, present, and future, in smelting iron ores. This contribution was largely of a historical nature. Its scope is sufficiently indicated by the title, and it would be a useful intellectual exercise for students to follow its reasoning.

Mr. Bauerman's paper on the iron and stsel exhibits at the Chicago Exhibition was of the usual nature of such papers. The principal wonders to be seen were referred to by the author, but it is unnecessary for us to follow him in his description. The same remark applies to Mr. Steavenson's paper, with the reading of which the first day's sitting was brought to a close. In the afternoon a very instructive and pleasant excursion was made to the Weardale Steel and Iron Company's works at Spennymore, where members had an opportunity of seeing the gigantic operation of cogging and rolling ingots, which are characteristic of the modern steel works.

The first paper taken on the second day's sitting was Prof. Ledebur's contribution on carbon in iron. This met with a mixed reception, the opinion of some members appearing to be that it was hardly worthy of the time allotted to it, although international courtesy forbade them blankly saying so. We think such an opinion can only be due to a cursory study of the paper, which appears to be one of considerable value, and especially suitable for the Transactions of the Institute. There is some controversial matter in this memoir, but its value is that it brings together in a very compact form many of the leading facts involved in the subject upon which it treats, and although there is not much in it that is new—in fact, the matter consists of that already known—yet many of the details are, as was stated by Mr. Hadfield, the result of the author's own research. The paper is well worth the consideration of metallurgists, and we think there are few who would not benefit by their memories being refreshed, even if the facts were not altogether new. Prof. Ledebur holds that there are four states of carbon in iron. The first is the graphitic state; the second, that which the author described as the temper-carbon; the third is a carbide carbon or cement carbon; and the fourth hardening carbon. It will be evident that in stating this the author opened up matter largely of a controversial nature, and in the discussion which followed, Mr. Snelus, Mr. Hadfield, Prof. Roberts-Austen, Mr. Stead, Sir Lowthian Bell, Prof. Thomas Turner, and Mr. Edward Riley took part. It is unnecessary to say that with all these gentlemen engaged in the discussion there was some clashing of opinion. Mr. Hadfield stated a most interesting fact, in that from a malleable iron casting he had obtained three per cent. of graphitic carbon; but we believe the casting showed all the physical qualities of having been well annealed. The result is of course not difficult to conceive, but the fact is none the less of interest. The action of silicon in regard to carbon in steel also occupied the attention of the meeting during this discussion, but we did not notice that any new facts were brought forward.

Mr. Bedson's paper on iron and steel wire was a very able contribution on a most interesting subject. The author is of the fourth generation of wire-makers, the business in which he is engaged having been handed down to him from his great-grandfather; whilst his father added some of the most important improvements to the machinery and process of wire manufacturing. The immense superiority of basic steel over that produced by the acid process was strongly insisted upon by the author; a fact which called forth some rather sharp remarks from Mr. James Riley, who protested against the acid Siemens steel being left unmentioned, as by far the greatest quantity of steel wire was manufactured from that metal. Mr. Bedson's paper was a long one; but if it had been even more extended, his audience would not have objected to it. For our own part, we should have been glad to have seen some mention made of the extraordinary tenacity in steel produced by drawing into wire.

The next paper taken was that of Mr. William Muirhead. Unfortunately this contribution was written in such a way that the author's meaning was somewhat obscure. From the wording of the paper we gathered that Mr. Muirhead would abolish the cogging process by which the ingot is broken down in rolls to manageable dimensions for rolling. This operation was originally performed by the steam hammer, and the cogging rolls were undoubtedly a great improvement, enabling work to

be done with more expedition and greater cheapness. The author in his paper certainly advocated abandoning both hammering and cogging. In his paper he said, "Cogging, as it is at present carried on, with its consequent reheating, is a cumbersome, almost an ugly operation, and from the arguments I have endeavoured to adduce, an unnecessary one. How much smarter and cheaper it will be to take the ingots and roll them right off into plates, and I commend this to your earnest attention." Yet in the discussion which followed, Mr. Muirhead said that he did not in his system do without cogging. The point is one of considerable importance, and, Mr. Muirhead's position as the manager of an important steel-producing plant commands for him attention. If the same results can be got from the ingot without cogging and reheating, undoubtedly a great step in advance will have been taken; but the majority of steel-makers—perhaps we might say all, with the exception of Mr. Muirhead—think that cogging or hammering is a necessary though expensive process. Of course, if the author can show that he is right, and the rest of the steel world wrong, he will have performed a signal service to the industry. If we were the owners of steel works, however, we should prefer the experiments to be carried out by other manufacturers. It may be added that what is known as the direct process of rolling is not a new thing, and for Mr. Muirhead to succeed he will have to introduce some entirely fresh element into his procedure.

The last paper read at the meeting was Mr. Clarkson's contribution, in which he described his ore sampling machine. It would seem a small matter, at first glance, to sample ore, but it is by no means an easy thing to do. The variations in quality or composition are arbitrarily distributed, and it may easily be that a sample made up from portions from several different positions in the mass to be sampled, may not be a fair representation of the whole. Machines have been before used, by means of which small portions of a falling mass of ore may be abstracted at regular intervals. It would be difficult to describe this device without the aid of diagrams, but it may be stated that though they appear to work fairly and equitably at first sight, they are in reality partial in their selection. Mr. Clarkson has brought a trained mind to bear upon this subject, and has produced a really scientific instrument. The mass of ore is caused to fall in an annular stream, descending into a hopper, which is made to revolve at great speed. By a suitable mechanism small portions of the ore are abstracted at regular intervals, and from the fact that the falling mass takes the form of an annulus in place of a solid stream, the tendency of certain qualities to gather in the middle of the stream is obviated. A small-sized apparatus was shown in the theatre, and the author was able to practically demonstrate the accuracy with which it worked, so far as the exact percentage of the material abstracted from the whole was concerned. The demonstration, it may be said, was perfectly successful. The apparatus has another useful field in distribution of a mass into equal parts, so that by it a number of bottles or boxes can be filled without the tedious process of weighing being gone through, and yet each receptacle will have its due share of the material. The error of the ore separator is less than at present.

This was the last paper read at the meeting, which concluded with the usual votes of thanks.

THEORIES OF THE ORIGIN OF MOUNTAIN RANGES.

IN his presidential address, delivered before the American Association for the Advancement of Science this year, Prof. Le Conte dealt with theories of mountain genesis—a subject which lies at the very foundation of theoretical geology. Want of space forbids us printing the address in full, but the most salient points are contained in the extracts from it that are here given.

Prof. Le Conte began by stating those fundamental features of the structure of mountain ranges on which every true theory of their origin must be founded. These features are: (1) Thickness of mountain sediments; (2) coarseness of mountain sediments; (3) folded structure of mountains; (4) cleavage structure; (5) granite or metamorphic axis; (6) asymmetric form. Another type of mountain, the main characteristics of which are not included under the above heads, are those only found in the Basin and Plateau regions, and therefore termed the Basin region type. In fact, "mountains may be divided into two types, viz. mountains formed by folding of strata, and mountains formed by tilting of crust-blocks. The structure of the one is anticlinal or *di*clinal, of the other, *mono*clinal. The Sierra probably belongs to both types. It was formed at the end of the Jurassic as a mountain of the first type, but the whole Sierra block was tilted up on its eastern side without folding at the end of the Tertiary, and it then became also a mountain of the second type. A complete theory must explain this type also; but since from the exceptional character it must be regarded as of subordinate importance, we shall be compelled to confine our discussion to mountains of the usual type."

Before going any further, however, Prof. Le Conte made a digression in order to clearly lay down what he meant by theory. After facts have been collected they must be explained, and the explanation, which merely gives the laws of the immediate phenomena in hand, is called the *Formal Theory*. The next step towards the perfection of knowledge consists in explaining the cause of these laws, and is termed the *Casual* or *Physical Theory*. The following is an illustration of this distinction:—

"All the phenomena of the drift are well explained by the former existence of an ice-sheet moving southward by laws of glacial motion, scoring, polishing, and depositing in its course. This is the formal theory. But still the question remains, What was the cause of the ice-sheet? Was it due to northern elevation, or to Aphelian winter concurring with great eccentricity of the earth's orbit? And if due to northern elevation, what was the cause of that elevation? A perfect theory must answer all these questions."

". . . . I wish to keep clear in the mind these two stages of theorising in the case of mountain origin. The formal theory is already well advanced toward a satisfactory condition; the physical theory is still in a very chaotic state. But these two kinds of theories have been often confounded with one another in the popular and even in the scientific mind, and the chaotic state of the latter has been carried over and credited to the former also; so that many seem to think that the whole subject of mountain origin is yet wholly in the air, and without any solid foundation."

Bearing in mind that "a true formal theory, keeping close to the immediate facts in hand, must pass gradually from necessary inferences from smaller groups to a wider theory which shall explain them all," Prof. Le Conte showed the inferences that could be made from the characteristic features of mountain structure, and he then grouped those inferences, and summed up his views as to the mode of mountain formation as follows:—

Summary Statement of the Formal Theory.

(1) "Mountain ranges, while in preparation for future birth, were marginal sea-bottoms receiving abundant sediment from an adjacent land-mass and slowly subsiding under the increasing weight. (2) They were at first formed and continued for a time to grow, by lateral pressure crushing and folding the strata together horizontally and swelling them up vertically along a certain line of easiest yielding. (3) That this line of easiest yielding is determined by the hydrothermal softening of the earth's crust along the line of thickest sedimentation. (4) That this line by softening becomes also the line of greatest metamorphism, and by yielding the line of greatest folding and greatest elevation. But (5) when the softening is very great, sometimes the harder lateral strata are jammed in under the crest, giving rise to fan-structure, in which case the most complex foldings may be near but not at the crest. Finally (6) the mountains thus formed will be asymmetric because the sedimentary cylinder-lenses from which they originated were asymmetric."

Several American examples illustrating these views were then given, and it was shown that eruptive phenomena, faults, mineral veins, earthquakes, and other minor phenomena associated with mountains are well explained by them. To quote Prof. Le Conte: "Leaving out the monoclinal type, which seems to belong to a different category, all the phenomena, major and minor, of structure and of occurrences, connected with mountains, are well explained by the theory of *lateral pressure* acting on lines of thick sediments accumulated on marginal

sea-bottoms, and softened by invasion of interior heat. This view is therefore satisfactory as far as it goes, and brings order out of the chaos of mountain phenomena. It has successfully directed geological investigation in the past, and will continue to do so in the future.

"But there still remains the question, 'What is the cause of the lateral pressure?' The answer to this question constitutes the *physical theory*.

"Thus far I suppose there is little difference of opinion. I have only tried to put in clear condensed form what most geologists hold. But henceforward there are the most widely diverse views, and even the wildest speculations. But let us not imagine, on that account, that we have made no progress in the science of mountain origin. The formal theory already given is really for the geologist by far the most important part of the theory of mountain origin. For I insist that for the geologist, *formal* theories are usually more important than *physical* theories of geological phenomena. That slaty cleavage is the result of a mashing of strata by a force at right angles to the cleavage-planes, is of capital importance to the geologist, for it is a guide to all his investigations. To what property of matter this structure is due, is of less importance to him, though of prime importance to the physicist. That the phenomena of the drift is due to the former existence of a moving ice-sheet is the one thing most important to the geologist, guiding all his investigations. Whether this ice-sheet was caused by geographical or astronomical changes, is a question of wider but of less direct interest to him. So in the case of mountain ranges, the most important part of the theory is their origin by *lateral pressure* under the conditions given above. The *cause* of lateral pressure, though still of extreme interest, is certainly of less immediate importance in guiding investigations."

The Contraction Theory.

"The most obvious view of the cause of lateral pressure refers it to the *interior contraction of the earth*. This theory is so well known that I will give it only in very brief outline. It assumes that the earth was once an incandescent liquid, and has cooled and solidified to its present condition. At first it cooled most rapidly at the surface, and must have fissured by tension. But there would inevitably come a time when the surface, being substantially cool, and, moreover, receiving heat also from the sun, its temperature would be fixed, or nearly so, while the incandescent interior would be still cooling and contracting. Such has probably been the case ever since the commencement of the *recorded* history of the earth. The hot interior now cooling and contracting more rapidly than the cool crust, the latter, following down the ever-shrinking nucleus, would be thrust upon itself by lateral pressure with a force which is simply irresistible. If the crust were ten times, yea, one hundred times more rigid than it is, it must yield. It does yield along the lines of greatest weakness, *i.e.* along marginal sea-bottoms, as already explained. As a first attempt at a physical theory, it seems reasonable, and therefore until recently has been generally accepted."

Objections to the Contraction Theory.

"It is well known that American geologists have taken a very prominent part in the study of mountain structure and mountain origin; so much so, indeed, that the lateral pressure theory in the form given above and interior contraction as its cause, have sometimes been called the 'American theory.' It is also well known that my name, among others—especially Dana's—has been associated with this view. All I claim is to have put the whole subject, especially the formal theory, in a clearer light and more consistent form.[1] The formal theory I regard as a permanent acquisition. The contraction theory may not be so. It is natural, from my long association with it, that I should be reluctant to give it up. But I am sure that I am willing to do so if a better can be offered. We all dearly love our own intellectual children, especially if born of much labour and thought; but I am sure that I am willing, like Jephtha of old, to sacrifice, if need be, this my fairest daughter on the sacred altar of Truth. Objections have recently come thick and fast from many directions. Some of these I believe can be removed, but others perhaps cannot in the present condition of science, and may indeed eventually prove fatal. Time alone can show. I state briefly some of these objections."

(1) "Mathematical physicists assure us that on any reasonable premises of initial temperature and rate of cooling of the earth, the amount of lateral thrust produced by interior contraction would be wholly insufficient to account for the enormous foldings (*Cam. Phil. Trans.* vol. xii. Part 2, December, 1873). Let us admit—surely a large admission—that this is so. But this conclusion rests on the supposition that the whole cause of interior contraction is *cooling*. There may be other causes of contraction. If cooling be insufficient, our first duty is to look for other causes. Osmund Fisher has thrown out the suggestion (a suggestion, by the way, highly commended by Herschel) that the enormous quantity of water vapour ejected by volcanoes, and the probable cause of eruptions is not meteoric in origin as generally supposed, but is original and constituent water occluded in the interior Magma. (*Cam. Phil Trans.* vol. xii. Part 2, February, 1875. "Physics of the Earth's Crust," p. 87.) Tschermak has connected this escape of constituent water from the earth with the gaseous explosions of the sun (*Geol. Mag.* vol. iv. p. 569, 1877). Is it not barely possible that we have in this an additional cause of contraction, more powerfully operative in early times, but still continuing? See the large quantity of water occluded in fused lavas to be 'spit out' in an act of solidification! But much still remains in volcanic glass which by refusion intumesces into lightest froth. Here, then, is a second probable cause of contraction. If these two be still insufficient, we must look for still other causes before rejecting the theory.

(2) "Again, Dutton (*Am. Jour.* vol. viii. p. 13, 1874; *Penn. Monthly*, May 1876) has shown that in a rigid earth it is impossible that the effects of interior contraction should be concentrated along certain lines so as to form mountain ranges, because this would require a shearing of the crust on the interior. The yielding would be evenly distributed everywhere, and therefore imperceptible anywhere. This is probably true, and therefore a valid objection in the case of an earth equally rigid in every part. But if there be a subcrust layer of liquid or semiliquid or viscous, or even more movable or more unstable matter, either universal or over large areas, as there are many reasons to think, then the objection falls to the ground. For in that case there would be no reason why the effects of general contraction should not be concentrated on weakest lines, as we have supposed.

(3) "But again, it has been objected that the lines of yielding to interior contraction ought not to run in definite directions for long distances, but irregularly in all directions. I believe we may find the answer to this objection in the principle of flow of solids under very slow heavy pressure. The flow of the solid earth, under pressure in many directions, might well be conceived as being deflected to the direction of least resistance, *i.e.* of easiest yielding.

(4) "But again, it will be objected that the amount of circumferential shortening necessary to produce the foldings of some mountains is simply incredible, for it would disarrange the stability of the rotation of the earth itself. According to Claypole, in the formation of the Appalachian range the circumference of the earth was shortened 88 miles, and in the formation of the Alps 72 miles. Now this would make a decrease of diameter of the earth of 28 miles in the one case, and 23 in the other. This would undoubtedly seriously quicken the rotation and shorten the day. This seems indeed startling at first. But when we remember that the tidal drag is all the time retarding the rotation and lengthening the day, and much more at one time than now, we should not shrink from acceptance of a counteracting cause hastening the rotation and shortening the day, and thus giving stability instead of destroying it. We must not imagine that there would be anything catastrophic in this readjustment of rotation. Mountains are not formed in a day, nor in a thousand years. It requires hundreds of thousands, or even millions of years—if physicists allow us so much.

"The objections thus far brought forward, though serious, are by no means unanswerable. But there is one brought forward very recently which we are not yet fully prepared to answer, and may possibly prove fatal. I refer of course to the level of no strain."

Level of No Strain.

"Until recently the interior contraction of the earth was considered only roughly and without analysis. It was seen that the

[1] "Theory of the Formation of the Great Features of the Earth's Surface." *Am. Journal*, vol. iv. p. 345 and 460, 1872; and also "Structure and Origin of Mountains," vol. xvi. p. 95, 1878.

surface was already cool, and its temperature fixed while the interior was still hot and cooling; and, therefore, that the exterior must be thrust upon itself and be crushed. But the phenomena are really far more complex than at first appears. It is necessary to distinguish between two kinds of contraction to which the interior layers are subjected, viz. radial and circumferential. If there were radial contraction only, then undoubtedly every concentric shell as it descended into smaller space would be crushed together laterally. But there is for all layers, except the surface, also a circumferential contraction, and this would have just the opposite effect, *i.e.* would tend to sfretch instead of crush. Therefore, wherever the decrease of space by descent is greater than the circumferential contraction, there will be crush; and where the circumferential contraction is greater than the decrease of space by descent, there will be tension and tendency to crack. There would be no *real* cracking, only because incipient cracks would be mashed out, or rather prevented by superincumbent pressure. Where these two are equal to one another, there will be no strain of any kind. There is a certain depth at which this is the case; it is called the 'level of no strain.' To Mellard Reade is due the credit of first calling attention to this important principle."

After a diagrammatic representation of this principle, the president continued as follows:—

"Now laborious calculations have been made by Davison, Darwin, and Fisher to determine the depth of this level of no strain. All make it very superficial. Davison, taking an initial temperature of 7000° F. makes it five miles below the surface. Fisher, on the same data, only two miles, and with an initial temperature of 4000 only 0·7 of a mile. It is easy to see that if this be true the amount of lateral thrust must be small indeed.

"Now undoubtedly there is a true principle here which must not hereafter be neglected, but it is almost needless to say that these quantitative results are in the last degree uncertain. The calculations are of course based on certain premises. These are a uniform initial temperature of, say, 7000° F., a time of cooling, say, 100 or 200 millions of years, and a certain rate of cooling under assumed conditions. The depth of the level of no strain increases with the time, and is still going downward. In a word, in a question so complex, both mathematically and physically, and in which the data are so very uncertain, every cautious geologist, while freely admitting the soundness of the principle, will withhold assent to the conclusions. Huxley has reminded us that the mathematical mill, though a very good mill, cannot make wholesome flour without good wheat. It grinds indifferently whatever is fed to it. It has been known to grind peas ere now. It may be doing so again in this case. Let us wait.

"But besides withholding assent, and waiting for more light, I may add that these calculations, of course, go on the supposition that the whole contraction of the earth is due to loss of heat; but, as we have already said, it may be due also to loss of constituent water. This would put an entirely different aspect on the subject."

Alternative Physical Theories.

"I have given the objections to the contraction theory frankly and, I think, fairly. They are undoubtedly serious. Let us see what has been offered in its place."

I. Reade's Expansion Theories.

This, the most prominent among alternative theories, was first brought forward in Mr. Reade's book on "Origin of Mountain Ranges." Although I have carefully read all that Mr. Reade has written on this subject, I find it difficult to get a clear idea of his views. But as I understand it, it is in outline as follows: (1) Accumulation of sediments off shore, and isostatic subsidence of the same. (2) Rise of isogeotherms and heating of the whole mass of sediments and of the underlying crust in proportion to the thickness of the sediments. (3) Expansion of the whole mass in proportion to the rise of temperature. If there were no resistance this expansion would be in all directions (cubic expansion). (4) But since the containing earth will not yield to expansion laterally, this lateral expansion is satisfied by folding, and this in turn produces vertical upswelling. Thus the whole cubic expansion is converted into vertical expansion, which is therefore three times as great as the linear expansion in any one direction. (5) Elevation would of course anyhow be greatest along the line of thickest sediment; but this by itself would not be sufficient to produce a mountain. (6) But farther—and here the theory is more obscure—there is a concentration of the effects of expansion, along a comparatively narrow line of thickest sediments, by a flow of the hydrothermally plastic or even liquid mass beneath, toward this central line, and then upward through the parted starta, folding these back on either side, and appearing at the crest as the granitic or metamorphic axis. (7) In his latest utterances he seems to adopt the view of Reyer, viz. that the uplifted strata slide back down the slope, producing the enormous crumpling so often found, and exposing a wider area of granite axis. (8) From the same liquid mass which lifts the mountain come also the great fissure-eruptions and the volcanoes.

"Mr. Reade makes many experiments to determine the linear expansion of rocks, and he thinks that these experiments show that when cubic expansion is converted into vertical expansion, and this again concentrated along a line of one-fourth to one-fifth the whole breadth of the expanding mass, it would explain the elevation of the highest mountains. But still he seems uncertain if it be enough. In fact, he declares that if it were not for another factor yet unmentioned, he probably would never have brought forward the theory at all.

(9) "This factor is recurrency of the cause and accumulation of the effects. And here the previous obscurity becomes intensified. I have read and re-read this part without being able wholly to understand him. He seems to think that when expansion had produced elevation, the mountain thus formed would not come down again by cooling and contraction; but, on the contrary, would wedge up by normal faulting, and set in its elevated position. Afterward, by new accumulation of heat, another elevation and setting would take place, and the mountain grow higher, and so on indefinitely or until the store of heat is exhausted. Therefore, he characterises his theory as that of 'alternate expansion and contraction,' or, again, as that of 'cumulative recurrent expansion.' Such is a very brief, perhaps imperfect, but I hope fair outline of Reade's theory. It seems to me that there are fatal objections to it. These I now state."

Objections to the Theory.

(1) "The first objection is inadequacy to account for the enormous foldings of mountains, especially when there is no granite axis to fold back the strata. It is true that Mr. Reade makes comparison between his own and the contraction theory in this regard, and seems to show the much greater effectiveness of his own. This may be true if we accept his premises, and compare equal areas in the two cases. But the contraction theory draws from the whole circumference of the earth, and accumulates the effects on one line, while in Reade's theory the expansion is of course very local.

(2) "But the fatal objection is that brought forward by Davison. It is this: sedimentation cannot, of course, increase the sum of heat in the earth. Therefore the increased heat of the sediments by rise of isogeotherms must be taken from somewhere else. Is it taken from below? Then the radius below must contract as much as the sediments expand, and therefore there will be no elevation. Is it taken from the containing sides? Then the sides must lose as much as the sediments gain, and therefore must contract and make room for the lateral expansion, and therefore there would be no folding and no elevation. I do not see any escape from this objection.

"Thus it seems that Reade's theory cannot be accepted as a substitute. Is there any other?"

II. Dutton's Isostatic Theory.[1]

"Dutton's discussion of isostasy is admirable, but his application of it to the origin of mountains is weak. The outline is as follows:—

"Suppose a bold coast line, powerful erosion and abundant sedimentation. The coast rises by unloading, and the marginal sea-bottom sinks by loading. Now, if isostasy is perfect, there will be no tendency to mountain formation. But suppose a piling up of sediments—but on account of earth rigidity—without immediate compensatory sinking, and a cutting down of coast land without compensatory rising. Then there would be an isostatic slope towards the land. And the accumulated and softened sediments would slide landward, crumpling the strata and swelling them up into a mountain range.

"The fatal objection to this view is that complete isostasy is necessary to renew the conditions of continued sedimentation,

[1] Phil. Soc. of Washington, Bull. Vol. xi. pp. 51-64, 1889.

and therefore to make thick sediments, otherwise the sediments quickly rise to sea-level, and stop the process of sedimentation at that place. But it is precisely a want of complete isostasy which is necessary to make an isostatic slope landward. Dutton refers to Herschel as having suggested a similar cause of strata crumpling and slaty cleavage (*Phil. Mag.* vol. xii. p. 197, 1856); but the principles involved in the two cases are almost exactly opposite. Herschel supposes sediments to slide down steep natural slopes of sea-bottoms, and therefore sea-ward. Dutton supposed sediments to slide up natural, though down isostatic slopes, landward. Herschel's is a theory of strata-crumpling and slaty cleavage, Dutton's a theory of mountain formation.

"There has been no attempt to carry this idea of Dutton's to quantitative detail. It was probably thrown out as a suggestion in mere despair of any other explanation, for he had already repudiated the contractional theory. But the least reflection is sufficient to convince that such slight want of complete isostatic equilibrium as may sometimes occur, would be utterly inadequate to produce such effects."

III. Reyer's Gliding Theory.[1]

"Prof. Reyer has recently put forward certain views fortified by abundant experiments on plastic materials. His idea in brief seems to be this: strata are lifted and finally broken through by uprising fused or semi-fused matters, and these appear above as the granitic axis. As the axis rises, the strata are carried upward on its shoulders, until when the slope is sufficiently steep the strata slide downward, crumpling themselves into complex folds and exposing the granitic axis in width proportioned to the amount of sliding.

"No doubt there is much value in these experiments of Reyer, and possibly such gliding does indeed sometimes take place in mountain strata, and some foldings may be thus accounted for. But the great objections to this view are: (1) that there is no adequate cause given for the granitic uplift, and (2) that it utterly fails to account for the complex foldings of such mountains as the Appalachian and Coast Range, where there is no granite axis at all. Reade, indeed, holds that the Piedmont region is the granite axis of the Appalachian, and that the original strata of the eastern slope are now buried beneath the sea. But American geologists are unanimous in the belief that the shore line of the great interior Palæozoic Sea was but a little east of the Appalachian crest and the sea washed against land of Archæan rocks extending eastward from that line."

Conclusion.

"After this rapid discussion of alternative theories, in which we have found them all untenable, we return again to the contraction theory, not indeed with our old confidence, but with the conviction that it is even yet the best working hypothesis we have."

GEOGRAPHY AT THE BRITISH ASSOCIATION.

AS in other sections, an absence of sensational papers, and an unusual abundance of good solid work, the outcome of study and research, were the characteristic features in Section E. The president's address was well adapted to his audience; the simplicity of its language, and the vivid descriptions of scenes in the Arctic Basin, with which it abounded, sustained the attention of every listener, and went over the head of none. Perhaps it was better calculated for the extension than the advancement of geographical science, but in many ways advance in geography depends on conditions different from those which determine advance in other sciences. Mr Seebohm rightly felt that to enforce principles familiar to professed geographers by a picturesque concrete example which no one could misunderstand was better than to record advances in specialised research, which could only appeal to the few geographers whose grasp of the subject equalled his own.

The section met on four days, and, including the presidential address, twenty-seven papers were read; a large number of members, in addition, took part in various discussions. A feature of the papers was the small number of mere records of travel, and the general striving after some kind of scientific elaboration of the data described. This was in some cases imperfectly done, but the imperfection was a consequence of the neglect of higher geographical education in this country, and the necessary beating out of new paths by independent workers, who, seeing the need for scientific treatment, are not always sure of the right methods to employ.

An inter-sectional discussion with Section C, on the limits between physical geography and geology, had been looked forward to with much interest, but proved somewhat disappointing. Few of the speakers addressed themselves to the subject announced, and in the extempore speeches it was evident that after a faint attempt to come to the point, there was a tendency to fall off on some familiar tack, and repeat irrelevant phrases often said before. In fact, there was no true discussion, as there was no distinct issue put forward.

Mr. Clements R. Markham, F.R.S., president of the Royal Geographical Society, commenced the proceedings by reading a paper, put together with consummate skill, in which he argued for the limit of human testimony as the line of demarcation between the domains of physical geography and geology. Thus he established a purely chronological division between phenomena of the same kind, which would fall to the province of one science or the other, according to the date of their manifestation. He concludes—

"Meanwhile, and until better instructed, I should define geology as the study of the condition of the earth and of the changes on its surface during the cycles of ages before the dawn of history; and I should define physical geography as a knowledge of the earth as it is, and of the changes which have taken place on its surface during historical times. These changes, derived from human testimony, explain to us the laws according to which similar changes are now taking place around us.

"The two sciences depend upon each other, and are very closely allied. The geologist finds the same phenomena in the rock formations of the past as the physical geographer discovers on the surface of the earth of the present. Both, for example, have the duty laid upon them of seeking out the agencies which rule in the processes of upheaval and depression. The fold, with its crest and trough, is common to both sciences; and geographers have rejoiced at the announcement of 'a wedding-ring of geology and geography uniting them at once and for ever in indissoluble union.'"

Mr. W. Topley, F.R.S., who followed, admitted the very close relations of geology and physical geography, but he devoted his attention to establishing the closeness of this relation by bringing forward numerous instances of the dependence of geographical features on geological structure, rather than to defining the limits of the two departments. His contention was that they merged the one into the other, and were not merely contiguous subjects separated by a discoverable line. Mr. E. G. Ravenstein supported Mr. Markham's chronological boundary, and summed up the conclusions of a racy speech in the statement that geology stands to physical geography in precisely the same relationship as history does to political geography. Prof. C. Lapworth, F.R.S., acknowledged the great difficulty of finding any satisfactory dividing line, contending that the geologist is in many ways absolutely dependent on the physical geographer, and the physical geographer in his turn absolutely dependent on the geologist, the physical geography of the present being indissolubly bound up with the physical geology of the past. Prof. Valentine Ball contended that the relation between geology and geography was similar to that between anatomy and art. Dr. R. D. Roberts, viewing geology as the history of the earth, argued that physical geography was merely the last chapter of that history. Dr. H. R. Mill suggested that a definition between the two departments of knowledge might be found rather in the aspect in which the phenomena of the earth were viewed than in the subject-matter or in chronological order. Physical geography being concerned with the present forms of the earth's surface borrowed from geology an explanation of the observed facts, taking results but not copying methods. Mr. H. Yule Oldham spoke of the unity of geography and of the importance of studying old travels in order to keep a record of recent physical changes. Prof. Bonney, F.R.S., characterised the discussion as waste of time and a search after the unattainable, for the words geography and geology contained in themselves all the definition that was required or could be found. Colonel Godwin-Austen and Mr. J. Y. Buchanan, F.R.S., made a few remarks; and Sir Archibald Geikie, who, by the consent of the presidents of Sections C and E, occupied the chair, summed up in a judicial manner. He

[1] NATURE, vol. xlvi. p. 224, 1891, and vol. xlvii. p. 81, 1892.

sympathised with the desire to determine the best line of cleavage between the two contiguous portions of science, but had to acknowledge that any line which might be definitely formulated would, to a large extent, be artificial and arbitrary.

Several papers on physical geography were read to the Section, but they did not approach the geological border. Mr. J. Y. Buchanan communicated the preliminary results of some new experiments he has been conducting on the effect of land, water and ice on the temperature of the air, which promise, when completed, to extend our knowledge of climatology. Dr. H. R. Mill summarised the effect of different degrees of isolation from oceanic influences on the seasonal changes of temperature in the water and air of the Clyde Sea area, and Mr. H. N. Dickson communicated a brief preliminary note on the results of his recent trip in H.M.S. *Jackal* for the Fishery Board for Scotland, in the course of which he had examined the temperature and salinity of the water between the north of Scotland and the Faroe Islands. Dr. Schlichter submitted a piece of solid work in pure physical geography in the form of a series of ten vertical sections drawn across northern and central Africa from west to east. These sections exhibit graphically the relative heights of the continent as far as they have been ascertained, and by the blanks which occur where fixed points are wanting, they bring into sharp prominence the regions which are still practically unexplored.

Papers on the latest explorations were read by Mr. E. G. Ravenstein, who traced the opening up of Msiri's country by the Katanga Company's expeditions, and by Mr. E. Delmar Morgan, who communicated an admirable summary of recent exploration in Tibet. Mr. W. M. Conway described his work in the Karakoram mountains. Dr. H. R. Mill referred to the work which he and Mr. Heawood had carried out this year in the "unexplored England" of the lake-beds.

Most interesting amongst the explorational papers were the brief accounts, given by Mr. W. S. Bruce and Dr. C. M. Donald, of the cruise of the Dundee whalers *Balæna* and *Active* toward the Antarctic regions.

Mr. Bruce's communication may be summarised as follows:—

"After a boisterous passage of over a hundred days on the steam whaler *Balæna*, from Dundee, we met the first iceberg on December 16, 1892, in 59° 40′ S. 51° 17′ W. We continued on a more or less southerly course, passing to the east of Clarence Island. Danger Islets were sighted and passed on December 23, and on Christmas Eve we were in the position Ross occupied on New Year's Day, 1843. Until the middle of February we remained roughly between 62° S. and 64° 40′ S. and 52° and 57° W., the western limit being Terre Louis Philippe and Joinville's Land.

"All the land seen was entirely snowclad except on the steepest slopes, which were of black, apparently igneous, rocks. The few specimens of rocks obtained from the ice and from the stomachs of penguins bear this out; Prof. James Geikie finding olivine, basalt, basalt lava, and possibly gabbro among them. Rock fragments and earthy matter were seen on some of the bergs and ice. On January 12 we saw what *appeared to be* high mountainous land and glaciers stretching from about 54° 25′ S. 59° 10′ W. to about 65° 30′ S. 58° 00′ W. I believe this may have been the eastern coast of Graham's Land, which has not been seen before.

"The whole of this district south of 60° S. is strewn with bergs, and south of 62° S. they become very numerous. No entire day was recorded when bergs were not seen; as many as 65, all of great size, to say nothing of smaller ones, were counted on one day. The longest we met was about 30 miles long, one was about 10 miles long, and several from 1 to 4 miles in length. The highest the *Balæna* sighted could not have been over 250 feet high, and many were not over 70 to 80 feet high. All the bergs were tabular, or weather-worn varieties of that form. The base of the bergs is coloured brown by marine organisms.

"The pack ice is said not to be heavier than that of the north, and is similar in nature. It is frequently coloured brown by *Corythrum criophyllum*, a very abundant diatom. We first met pack ice on December 14, in 62° 20′ S. 52° 20′ W.; it was dense, and ran east and west. In January we met the pack edge running east and west in 64° 37′ S. from about 54° to 56° W.

"A few observations for the freezing and melting-point of ice were made, and some sea temperatures recorded. The lead was cast in the vicinity of Danger Islets, and some bottom samples obtained, the depth varying from 70 to over 300 fathoms.

"Periods of fine calm weather alternated with very severe gales, usually accompanied by fog and snow. The lowest air temperature recorded was 20·8° F. on February 17, and the highest 37·60° F. on January 15. December showed an average of 31·14° F., January 31·10° F., and February 29·65° F. The barometer never rose above 29·804 inches.

"No whale resembling *Balæna mysticetus*, *i.e.* the Bowhead or Greenland black whale, was seen; but many finbacks, some hunchbacks, bottlenoses, grampuses, and several kinds of seals, the hunting of which in default of whales was the object of the voyage."

Messrs. Bruce and Donald showed a very creditable collection of observations, but the main outcome of their papers was a demonstration of the immense value of the results which would accrue from a purely scientific expedition to Antarctic waters. Mr. Bruce announced that he was prepared to spend a year, with an assistant who had volunteered to accompany him, on South Georgia or on Grahamsland, if he could be landed there, and to undertake systematic scientific work during that time, if his passage-money and maintenance were paid for. Mr. J. S. Keltie, Mr. H. O. Forbes, Mr. Coles, Dr. H. R. Mill, Mr. Ravenstein, Sir George Bowen, Mr. G. J. Symons, F.R.S., Colonel Fred. Bailey, and others, pointed out the immense importance of Antarctic exploration to geography, geology, meteorology, and other sciences, and warmly commended Mr. Bruce's resolution to conduct a series of preliminary observations. The audience, which included Dr. Burdon Sanderson, the president of the Association, received the papers and discussion with enthusiasm, and a subscription list was started in order to supplement any grants which might be obtained from learned societies to provide a scientific outfit for Mr. Bruce and his assistant. A committee of Section E was charged with the necessary arrangements, with Mr. Clements R. Markham as chairman, and Dr. H. R. Mill as secretary. The Committee of Recommendations voted a grant of £50 for the purposes of this committee. The question of Antarctic exploration was supported by a letter from Sir Erasmus Ommaney, enclosing an appeal from the Australian Antarctic Explorations Committee, suggesting that the British Association should take steps to induce the Australian Government to subsidise southern sealing voyages. A collection of water-colour sketches, by Mr. W. G. Burn-Murdoch, of Edinburgh, who was a passenger on the *Balæna*, illustrating the scenery and incidents of the voyage, was arranged round the meeting room, and attracted a great deal of attention. The collection has already been shown in Dundee, and arrangements have been made for exhibiting it in London in the map room of the Royal Geographical Society. Unfortunately, there were no press representatives in the meeting-room during the greater part of the Antarctic discussion, and it has consequently almost entirely escaped attention in the daily papers.

Papers on special parts of the world, summarising results of travellers and geographers, were read by Mrs. Lilly Grove, on the Chiloe Islands; by Mr. Howard Reid, on the relation of Lake Tanganyika to the Congo; and by Mr. Cop Whitehouse, on the Lower Nile Valley, with reference to the various delineations of it in Ptolemaic and later maps. Mr. E. Heawood read a paper recounting his experiences in the Bengal Duars, with special reference to the settlement of Santal colonists in that region. Mr. Heawood said:—

"The term 'Duars' is applied to a tract of country lying along the foot of the Himalayas of Bhután, and including the 'doors' or passes into that country. The first ranges here rise like a wall, wooded to their summits, from an undulating plain of slight elevation, which embraces a strip of forest-clad 'Terai' and a more open country further south. Over a great part savannahs of gigantic grass alternate with patches of forest, sál on the higher and lighter soils, and mixed forest fringing the streams. The grass is burnt down annually, and the trees with which it is dotted are usually quick growing and shed their leaves annually, and are thus less affected by the burnings. The tiger, leopard, bear, elephant, rhinoceros, buffalo, bison (so-called), pig, and several kinds of deer inhabit the jungles. The peacock, jungle-fowl, florikan, parrots, and a handsome pigeon are the most prominent birds. The rainfall is very great, and the climate unhealthy, though this improves with clearing. The tract is sparsely inhabited, except in the southern and newly-settled parts, by Mechs, a tribe of Mongolian affinities who can thrive in spite of the malaria. They are of wandering habits, cultivating by

burning patches of jungle, and moving on to new spots after a few years. Much of the land is very fertile, and well suited for both early and late rice crops. Channels, often of great length, are dug by the Mechs from the numerous streams for the irrigation of the late rice crops, though the tendency of the rivers to deepen their beds in the friable soil is a difficulty to more permanent settlers. The climate and the exposure to raids from Bhután have keep the country in a backward state. It became British territory as a result of the war of 1864. Much land has since then been settled and tea-gardens opened, especially in the western part; while within the last three years a large tract of jungle has been provisionally set apart by Government—at the instance of the Rev. A. J. Shields, C.M.S. missionary to the Santals, warmly supported by Mr. D. Sunder, settlement officer at Jalpiguri—for settlement by Santals, who in their hill country south of the Ganges are often unable to obtain sufficient land for cultivation. Forty families were taken up in 1891, the author assisting in their settlement, and still larger numbers have followed since. Although the partial failure of the rains in the first season caused unforeseen difficulties at first, these, it is hoped, are now in a fair way to be overcome. It should be mentioned that a similar experiment has been tried with success in Assam by a Norwegian mission."

Captain Williams, R.A., gave a popular address on the people of Uganda; Mr. Herbert Ward sent a short paper on the people of the Congo Basin; and Dr. R. W. Felkin submitted a new scheme for a map of the distribution of diseases in Africa. The Rev. C. H. Robinson gave an interesting account of the adventures of a Hausa pilgrim who passed through Khartum on the way to Mecca immediately after the capture of the town by the Mahdi, and gave a new version of the story of General Gordon's death. Mr. E. G. Ravenstein read a brief report of the Committee on African Climatology, which is engaged in accumulating meteorological data from the tropical parts of the colony.

Many of the communications were illustrated by the lantern, and the last paper read was on a system of geographical teaching in which the lantern is adapted for general use in schools, by Mr. B. Bentham Dickenson, of Rugby. A small association has been formed in order to promote this object.

The meetings of the Section were never attended by a larger average number than this year, and on the whole the scientific value of the papers has seldom been greater.

MECHANICS AT THE BRITISH ASSOCIATION.

IN Section G, that devoted to mechanical science, at the recent Nottingham British Association meeting, there were fewer papers read than usual. This, however, was a distinct advantage, for this section has generally suffered from an overabundance of matter. It is far more satisfactory to have a few good papers well discussed than a multitude of mediocre or inferior contributions, which only weary the audience, and lead to no good result. The section held its meetings in the Engineering Lecture Theatre, at University College, and the first sitting took place on Thursday, September 14, according to precedent. The president this year was Mr. Jeremiah Head, whose address we reprinted on September 21. The first paper taken was a contribution by Mr. Beaumont, entitled the "Automatic Balance of Reciprocating Mechanism," and referred to a method of utilising the vibration caused by a revolving weight for working sieves. In the discussion which followed, the opinion was expressed that the device might find a useful place in other applications than that for which it was originally intended. The rest of Monday's sitting was taken up by a description of lace machinery and hosiery machinery. Although the subject is one of considerable interest, it would be impossible to give any adequate idea of the proceedings without the numerous diagrams and lantern slides which were used by the author of the paper. Several of the most interesting machines described were shown at work in an adjoining room, and their action was explained by Mr. W. Robinson, the Professor of Engineering at University College, Nottingham.

On Friday, the 15th inst., two reports were down for reading; the first that of the committee on the dryness of steam in boiler trials, in regard to which Prof. Unwin stated that practically nothing had been done during the past year, and therefore there was no report to present. It was hoped, however, that by following certain lines of investigation which had been suggested by some American experimentalists, that good results might be arrived at, and it was hoped that a satisfactory report would be prepared for the next meeting. The report of the committee on Graphic Methods was a contrast to Prof. Unwin's statement; it being of an exceedingly voluminous character. This is the second long report that has been presented by the committee. It would be quite impossible to deal with the subject in an account of the proceedings such as we are able to give, which must necessarily be brief, and as the report will be printed in full, in common with all reports of committees, in the Proceedings, we will refer our readers to the volume when it is issued, for information on this really important subject. It is fair, however, to notice the immense amount of good and sound work that Prof. H. S. Hele Shaw has done, as secretary, in preparing the reports of this committee.

Two papers on the disposal of refuse followed; one by Mr. C. C. Keep, and the second by Mr. William Warner. In these various descriptions of destructors which had been placed upon the engineering market were described. Both authors are, we believe, members of firms which manufacture and sell apparatus of this description, and trade interests were not altogether lost to sight. The subject of refuse destruction is one of great importance, but it requires, in the interests of sanitary science, to be handled in a somewhat different manner to that pursued by the section in the reading and discussion of the papers. Mr. Frank Ashwell next read a paper on "Warming and Ventilating," in the course of which he discussed the merits of the plenum system, as against the method of ventilation by partial vacuum. He had not much difficulty in establishing the claims of the former; the chief advantage, of course, being that with a plenum inside the building any leakage there may be at doors, windows, &c. does not admit draught; the air for ventilation always coming in through the proper entrance, where it may be warmed, filtered, and, if necessary, moistened. Watchmaking by machinery next occupied the attention of the section, Mr. T. P. Hewitt, of Prescot, reading an interesting paper on the subject. As was stated by a speaker during the discussion which followed, watchmaking in England has been lately at a very low ebb. For many years it has had to meet the competition of cheap labour in Switzerland, but the most fatal blow to the system was struck by the introduction of the factory system for the manufacture of watches in America. By the use of machine tools and labour-saving appliances the Americans have been able to produce excellent timekeeping watches at a very moderate cost; for the industry is one specially suited to the genius of the American mechanic, whose inventive faculties are proverbial. So serious a blow has thus been inflicted on the English watchmaking industry that its operatives were brought to the greatest distress. Prescot, in Lancashire, is a very ancient centre of watchmaking, that is, so far as the movement of the watch is concerned, and many of the best English watches have Prescot works. It is in this town that an endeavour is being made to revive the English watchmaking industry, but on entirely new lines. A large factory has been built, and the most improved appliances introduced. These, of course, are largely American in origin, but it is satisfactory to know that the beautiful machine tools, such as used by the Waltham and Elgin Watch Companies, can now be made in England, and are equal to the productions of the United States. Several examples of these machines were exhibited during the reading of the paper.

Mr. Ross, of Glasgow, next described a pneumatic caulking and chipping tool. This is a hand-tool, working, as its name would imply, by compressed air, or steam may be used. It will make over 10,000 strokes per minute, and consists essentially of a small cylinder and loose piston, which works on to the caulking or chipping chisel. The only thing the operator has to do, therefore, is to guide the tool, and the enormous rapidity of the strokes enables the finest work to be done, either in caulking a metal seam or in chipping down a metallic surface. Some very beautiful specimens of work were shown at the meeting, and the instrument itself was exhibited.

It is the custom of Section G to devote Monday of the Association meeting to electrical science, and the first paper taken on the 16th was a contribution by Mr. Gisbert Kapp, entitled "Relative Cost of Conductors with Different Systems of Electrical Power Transmission." This was a most useful paper, and a good example of the form contributions on electrical subjects should take in Section G, where, it must be remembered

electrical engineering, and not physics, should be treated upon. The author said that until recently, electrical machines for the transmission of power were of the continuous current type, but lately alternate current apparatus had come into use, chiefly because the power could be carried to greater distances with a moderate cost of conductors. The reason for this was that with continuous current plant the voltage is limited by the difficulty of insulating the generating machinery. With alternate current there is no necessity of high insulation of generator or motor, but only of the transformers, which can be easily insulated by the use of oil or other means. The author dealt with five systems of transmission.

(1) Single phase alternating current transmission by two wires.
(2) Double ,, ,, ,, ,, ,, four ,,
(3) ,, ,, ,, ,, ,, ,, three ,,
(4) Three ,, ,, ,, ,, ,, three ,,
(5) Continuous current with transmission by two wires.

We have not space to follow Mr. Kapp's ingenious reasoning, but will briefly give his conclusions. If all systems were put on the same footing as regards efficiency and safety of insulation, the following results would be obtained. If, for the transmission of a certain power over a given distance by continuous current, 100 tons of copper were required for the line, then the single phase alternating and the two phase four wire system would require 200 tons. The two phase three wire system would require 290 tons, and the three phase three wire system only 150 tons; therefore, so far as the line might be concerned, there would be a distinct advantage in the employment of the three phase system.

A paper by Mr. A. B. Snell, "On Water Power as a Source of Electricity," was next read. The subject is not one of such great practical importance in England as in more mountainous countries. Our rivers are small, and in comparatively few cases is there sufficient head to make the utilisation of them profitable with such a form of water motors as have yet been introduced. Mr. Beaumont described a variable power gear for electrical locomotives which he had devised. The object of the gear is to give increased power for the motor when starting the train. By its use the designer hoped that electric motors might be made of very much smaller size. A point of interest raised during the discussion was the advisability of using epicycloidal gear, it being the opinion of Prof. Hele Shaw and others who had worked with this gear that it was not suitable for heavy loads. Mr. W. B. Sayers read an interesting and valuable paper, in which he described a form of self-exciting armature and compensator for loss of pressure, which he had devised. The invention is one of considerable importance, the object being to obtain sparkless commutation. The device, however, is not quite new, it having been previously described, and doubtless is known to the majority of our electrical readers. Monday's proceedings closed with a paper by Mr. E. Payne, on "Electrical Conductors."

Tuesday, September 19, was the last day on which Section G met, and the proceedings opened with a paper by Mr. O. T. Olson, on "Flashing Lights for Marine Purposes." The author proposed that each important navigational light in the world should have a distinctive number which it should continuously flash at night, so that there might be no danger of any particular light being mistaken by the mariner for another. During fog the signals were to be conveyed by gun-cotton explosion. Probably Mr. Olson's suggested signals are somewhat too complicated, although possibly as simple as could be practically arranged were every light given a separate number. Nevertheless, something might be done towards systematising the signals given by various lights in certain geographical sections.

Mr. William S. Lockhart gave an interesting description of an automatic gem separator which he had devised. The apparatus acts by means of the difference in specific gravity between the gems and the gravel, quartz, &c., in which they are found. A stream of water flowing at a uniform velocity is directed upwards through an annular chamber. The material to be separated is fed in through a hopper at the top of the apparatus, and falls into the annular chamber. The velocity of the stream is so regulated that the lighter and more worthless substances are carried with it, whilst the heavier gems descend into a receptacle at the bottom of the machine. One of the separators was shown at work in the Section, water being laid on for the purpose, and some diamonds were actually separated from the pebble and quartz with which they were mixed. There are, it is hardly necessary to say, many points in detail which require careful consideration in working out before such a machine as this is brought to the perfection of practical working. Mr. Lockhart appears to have been very successful in overcoming the difficulties of the problem he had to solve in designing the machine.

A paper by Mr. Walker, "On Ventilating Fans," was read, and the proceedings in this Section closed by Prof. Robinson describing the Wicksteed testing machine, which had been erected in the engineering laboratory of the college. The members of the Section were able to see this machine in action during the afternoon. In most respects it does not differ from the ordinary type of Wicksteed testing machine, but there is a clever gear for shifting the poise. This was operated by hydraulic power by means of wire rope. The device is undoubtedly an improvement on the old gear, both in rapidity of action and absence of noise. There is a neat parallel adjustment for preventing the pulley of the rope influencing the result of the test.

The proceedings in Section G were brought to a conclusion by the usual vote of thanks to the sectional president, Mr. Jeremiah Head.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

AFTER the President's address on Thursday, Mrs. Lilly Grove read a paper on the ethnographic aspect of dancing. Dancing corresponds to a universal primitive instinct in man. At all periods there were three kinds of dances: (1) the imaginative or poetic; (2) the descriptive; (3) the religious. This last is most important, and may be called the fountain of the other kinds. Religious dances can be divided into two classes: (*a*) dances directly in honour of the deity; (*b*) dances intended to propitiate the deity. A strange feature is the fact that so many dances are performed in a circle. War-dances are of two orders, either as a preparation for war, or as a rejoicing after triumph. The Corroboree illustrates the former aspect. Excellence in dancing among savages is obtained by very simple means: anyone who makes a mistake is killed.

Prof. Windle read a paper on anthropometric work in schools. It appears from answers to a circular sent to the head-masters of one hundred of the largest schools in the United Kingdom, that some form of measurement is or has been carried on in twenty-five schools, but that the methods adopted differ considerably. The author suggested that an endeavour should be made to encourage and systematise such work.

Dr. W. Wilberforce Smith read a paper on anthropometric weighing; and the following reports were also presented to the section: Report of the Anthropometric Laboratory Committee, and Report of the Physical Deviations Committee.

On Friday, the committee appointed to make an ethnographical survey of the United Kingdom presented their first report. Prof. Hans Hildebrand then read an important paper on Anglo-Saxon remains and coeval relics from Scandinavia. The question proposed was to determine the relations which existed between the civilisation of Scandinavia and that of England during the period between the arrival of the Angles and the Saxons on the English coast, and the time of their conversion to Christianity; roughly, that was from the middle of the fifth to the middle of the seventh century of our era. These limits were not exactly determinable, because both the Anglo-Saxon immigration and the spread of Christianity among the newcomers were not the work of a few years only, and progressed with very different rapidity in different parts of the country. During this period Sweden had no chronological record, and Christianity had no hold on that country until the eleventh century. The criterions of date, therefore, on the Scandinavian side were of purely archæological character. There were a few instances of Roman and Byzantine coins found associated with Scandinavian antiquities, and as these could hardly have found their way northward before the downfall of the Hunic Empire in Central Europe, they gave some indication of the date of the objects with which they were lost or interred. In England similar date evidence occurred, but was vitiated by the fact that the coins had often been long in circulation before they were buried. The practice of burial also, while it entirely superseded cremation when Christianity became predominant, appeared to have coexisted with the older method during the later Pagan period, and could not be taken as affording an accurate criterion of age.

And there was the further difficulty in comparing English and

Scandinavian objects, that in England the Teutonic peoples found the British and Romano-British culture already existing on their arrival, while there was no parallel influence to modify the style of Scandinavian art. The author discussed the Scandinavian types of sword and spear, which presented both remarkable likenesses and differences when compared with those which gave their name to the Saxons (sword-men) and the Angles (spear-men). The boar-crest on the helmet also appeared to be a point of similarity. Numerous examples were adduced to show how designs borrowed from existing art were modified to suit Teutonic taste in the English series, which herein came nearer to the French and Belgian than to the Scandinavian. As illustrations of the development of style, the ornamental fibulæ or brooches were of especial importance, and a number of types were instanced which showed the fundamental likeness of Teutonic taste on both sides of the North Sea, combined with differences in detail. Summing up his results, Prof. Hildebrand concluded that a common Teutonic taste was the source of the art styles both of Scandinavia and of Saxon England; that the Scandinavian and Anglo-Saxon races were of closely allied Teutonic descent, but that in the incessant movements characteristic of that stock, the two branches were separated from one another and developed independently; that the Kentish Jutes and the Saxons of England came not from Scandinavia, but from Germany; but that the case was not clear with regard to the Angles, who might possibly not be of German origin, but may have been settled at one time in the south-west corner of Scandinavia.

In a paper on the "Origin and Development of Early Christian Art," Mr. J. Romilly Allen traced the various decorative elements found in early Christian art in Grea Britain to their source, and showed in what way the native styles of art existing in this country at the time of the introduction of Christianity (*circa* A.D. 450) were influenced, first by the Italo-Byzantine art, which came in with the importation of the illuminated manuscripts used in the services of the church, and subsequently by the coming in contact of the Anglo-Saxon and Scandinavian conquering races with the Celtic and other populations already inhabiting the British Isles.

The following papers were also read:—Note on an implement of hafted bone, with tooth of hippopotamus inserted, from Calf Hole, near Grassington, by the Rev. E. Jones; the prehistoric evolution of theories of punishment, revenge, and atonement, by G. Hartwell Jones; four as a sacred number, by Miss A. W. Buckland.

On Saturday the following papers were read:—On ancient metal implements from Egypt and Lachish, by Dr. J. H. Gladstone, F.R.S.; notes on flint saws and sickles, by Dr. R. Munro; prehistoric remains in Crete, by J. L. Myres; funeral rites and ceremonies among the Tshinyai or Tshinyangwe, by Lionel Decle; the Arungo and Marombo ceremonies among the Tshinyangwe, by Lionel Decle; the Ma-Goa, by Lionel Decle.

On Monday, a paper by Mr. Herbert Ward was read, entitled "Ethnographical Notes on the Congo Tribes." In it the author gave a sketch of all the salient features of native life in the Congo region, the subjects treated at greatest length being those relating to superstition and general customs. In the description of the "N'Kimba" ceremony of the Lower Congo natives, the motive for this remarkable "secret society" was, for the first time, explained.

Dr. Crochley Clapham read a paper on "The Mad Head," in which he said that the older phrenology of Gall had been superseded by Ferrier's cerebral localisation. He then gave some results of his examination of nearly 4000 insane heads drawn from eight asylums in the north of England and the south of Scotland, and compared with a number of sane heads. Insane heads he found to show a larger average size than sane ones, though insane brains were smaller. His standard of comparison was by a cranial index which he obtains by adding together the measurements of the whole circumference and the antero-posterior and transverse arches of the head. Of these measurements that of the transverse arch was the only one smaller in the insane, and was, in fact, their weak point. The cranial index he found further useful as, when expressed in inches, it showed about the weight of the normal contained brain in ounces. The frontal segment of the head circumference bore a larger proportion to the whole circumference in the insane than in the sane, and this, taken with the fact that the frontal lobes in idiots and imbeciles weigh more in proportion to the whole encephalon than in the total insane class, and the fact that the typical insane head was cuneiform with the greatest transverse diameter anterior to the central point of the head, seemed to discredit the "noble forehead," and to point out the occipital lobes as the seat of intelligence. This view was supported by facts of brain development and comparative cerebral anatomy, as well as by the flat occiput of idiots and the cerebellum of the bushman projecting beyond the occipital lobes.

In a paper on pin-wells and rag-bushes, Mr. E. Sidney Hartland suggested that the object of the usages was union with the divinity, to be achieved by the perpetual contact with the god of some article identified with the worshipper.

The following communications were also received:—Report of the Abyssinian Committee. On the external characters of the Abyssinians examined by Mr. Bent, by Dr. J. G. Garson; on the Dards and Siah-Posh Kafirs, by Dr. J. Beddoe and Dr. Leitner; the Primitive Americans, by Miss J. M. Welch; the Indians of the Mackenzie and Yukon Rivers, Canada, by the Rt. Rev. Dr. Bompas, Bishop of Selkirk; the Australian natives, by Miss J. A. Fowler; on a modification of the Australian aboriginal weapon termed the Leonile, Langeel, Bendi, or Buccan, by R. Etheridge, jun.; on an unusual form of rush-basket from the northern territory of South Australia, by R. Etheridge, jun.

On Tuesday, Mr. Francis Galton read some official letters just received by him from Surgeon Lieut.-Colonel Hendley, of Jeypore, who had memorialised the authorities in India in favour of affixing to the nominal roll of recruits an impression in ink of the fore, middle, and ring fingers of each recruit. In reply, the Commander-in-Chief "approved of the proposal to employ prints of finger-tips as marks for identification, as they are so extremely easy to make, and so useful in guarding against personation." Surgeon Lieut.-Colonel Hendley has had considerable experience in taking such imprints, having already sent to Mr. Galton those of the digits of nearly 1000 persons, most of whom were prisoners in the gaol of Jeypore.

Dr. Munro read a paper on the structure of lake-dwellings, in which he described the various methods adopted by the lake-dwellers in the construction of the understructures and platforms on which their huts had been placed. In conclusion, Dr. Munro gave a description of an important discovery recently made in Argyllshire. This was a crannog showing foundations of a circular house thirty-two feet in diameter, and divided into two compartments, one of which contained a hearth and the remains of a doorway.

Mr. Arthur Bulleid then read a paper on a British village of marsh dwellings. This village, discovered by the author in March, 1892, is situated a little more than a mile north of the town of Glastonbury, in the upper part of one of the moorland levels of central Somerset, found to the south of the Mendip Hills. There is little on the surface to indicate the site of a village, but on careful inspection between sixty and seventy low circular mounds may be seen, varying from 15 to 35 feet in diameter, and from 6 in. to 2 ft. 6 in. high at the centre. These form the foundations or floors of separate dwellings, which are constructed in the following way:—On the surface of the peat is a layer or platform of timber and brushwood, kept in place by numerous small piles at the margin. On this a layer of clay is placed, slightly raised at the centre, where the remains of a hearth are generally found. The dwelling itself was composed of timber filled in with wattle and daub. Not only have the wall-posts been found *in situ*, but also the entrance threshold and doorstep. Among other things that have been discovered is a boat 17 ft. long, quantities of wheel and hand-made pottery, sling stones, and bones of animals, and a great number of objects of bronze and iron, horn, bone, and stone, such as fibulæ and rings, knives, saws, and weapons, combs, needles, pottery stamps, and querns.

In a paper on the place of the lake dwellings at Glastonbury in British Archæology, Prof. Boyd Dawkins referred to the existence of crucibles to show that smelting had been carried on, and reasoned that the time of the occupation of the place was pre-Roman.

The following communications were also received:—On the excavation of the stone circle of "Lag ny Boiragh," on the Meayll Hill, Isle of Man, by Prof. W. A. Herdman, F.R.S., and P. M. C. Kermode; early uses of flint in polishing, by H. Stopes; palæolithic anchors, anvils, hammers, &c., by H. Stopes; Report of the Uniformity in Spelling Committee; Report of the North-Western Tribes of Canada Committee.

THE EVOLUTION OF COLOUR IN THE GENUS MEGASCOPS.

THE *American Naturalist* of June and July contains an article by Mr. E. M. Hasbrouck on "Evolution and Dichromatism in the Genus Megascops," in which he deals with the distribution of the genus in North America in relation to the colour of its plumage. The discussion leads to the following conclusions:—

"The red phase is confined mainly to *Megascops asio* (speaking of it as a whole), which, on its northern border, merges into the grey phase; the southern grey belt incompasses *floridanus*, while in eastern Texas the few red specimens of *mecallii* that are known have been taken from the extreme north-eastern portion of its range, which is influenced both by humidity and temperature. Again this distribution of colour corresponds very closely to the life areas—the grey phase of the Florida form in the south occupying a major portion of the Austro-riparian; the red phase of *asio* proper conforming very closely to even the outlines of the Carolinian, while the grey phase is equally identical with the Alleghanian.

"It is worthy of note that the grey phase of *Megascops asio* is boreal in its affinities, and that where a grey phase of *asio* is found that is not boreal, it is recognised as a sub-species.

"Now if *floridanus* (grey) is separable from *asio* just north of it (red), it seems highly probable that *asio* (red) will some day be separated from the grey phase on the north. It has been shown that as regards the two phases of *asio*, certain areas are inhabited exclusively by reds, certain ones exclusively by greys, while still others are inhabited by a mixture of the two, and that three forms (*floridanus* and two colour phases of *asio* proper) inhabit, as a whole, entirely distinct areas. No one will deny that all of the forms of *Megascops* are descended from a common ancestor, and if through climatic or environmental conditions they have become sub-specifically differentiated in various localities, I see no reason to doubt that in like manner, under the influence of humidity, temperature, acquired character, and forest area, which will be felt for countless generations to come, that the species now known as *Megascops asio* will one day be separated into species and sub-species—the former represented by the original grey, and the latter by the more modern red."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Medical Session began on Monday in the schools attached to the London and provincial hospitals. Dr. W. Pasteur delivered the introductory address at Middlesex Hospital, and Mr. Thomas Holmes at St. George's Hospital. The subject of Mr. Holmes's discourse was the life and works of John Hunter, being the centenary celebration of Hunter's death within the walls of the hospital. The address at St. Mary's Hospital was delivered by Mr. J. Ernest Lane, and at the London School of Medicine for Women by Miss Helen Webb. Biology and ethics formed the subject of the opening address delivered by Sir James Crichton Browne at the Sheffield School of Medicine.

MR. WALTER GARSTANG, of the Plymouth Marine Biological Laboratory, has been elected to a Research Fellowship by Lincoln College, Oxford.

THE first entrance scholarship to St. Thomas's Hospital Medical School, of the value of £150, has been awarded to Mr. Robert Wynn Charles Pierce, and the second, of the value of £60, to Mr. Harry Edward Hewitt.

THE Entrance Scholarship, of the value of 120 guineas, to Charing Cross Hospital Medical School has been awarded to Mr. Harold A. T. Fairbank, and that of the value of 60 guineas to Mr. Stanley W. R. Colyer.

THE following entrance scholarships to Guy's Hospital have been awarded in science. First, of the value of £150, to Philip Turner, University College, London; second, value £60, to George Ernest Richmond, Owens College.

THE Balfour Studentship, of the nett annual value of £200, will be vacant on October 18. From the regulations sanctioned by the Senate of the University of Cambridge, it appears that the studentship is not awarded upon the result of a competitive examination, and the student need not be a member of the University. The holder of the studentship must devote himself, however, to original biological inquiry, and must not follow any business or profession, or engage in any educational or other work, which, in the opinion of those charged with the administration of the Balfour Memorial Fund, would interfere with his original inquiries.

MR. W. TOWNSEND PORTER has investigated the relation between physical development and success in school life, his data for discussion being obtained from 33,500 boys and girls in the public schools of St. Louis (Transactions of the Academy of Science of St. Louis, vol. vi. No. 7). The weight of a child can usually be taken as a trustworthy index of physical development, and, comparing it with standards of intelligence, it appears that precocious children are heavier, and dull children lighter than the average child of the same age. Not only is this the case, but precocious children are taller, have larger chests, and wider heads than dull children. An examination has also been made of the relationship between precocity and rate of growth, or yearly increase in size, and the results indicate that the difference in weight between dull and precocious boys increases as they grow older. The conclusions arrived at are based upon means and averages, and may not be applicable to individuals. However, one deduction of considerable importance is made. It is that no child whose weight is below the average of its age should be permitted to enter a school standard beyond the average of its age, except after such a physical examination as shall make it probable that the child's strength shall be equal to the strain.

SCIENTIFIC SERIALS.

THE *Meteorologische Zeitschrift* for July contains an account of observations taken at the Hawaiian Islands, communicated by Dr. Marcuse, of the Berlin Observatory, who for some time visited Honolulu for astronomical investigations. The position of those islands, near the northern limit of the tropical zone, is very important from a meteorological point of view, and the Hawaiian Government have for some years past established a regular service under Mr. C. J. Lyons, who publishes a monthly meteorological summary. The principal station is at Punahou (Oahu), a little to the north-east of Honolulu, on which island there are also sixteen other stations, also twenty-three stations on the island Hawaii, and fourteen on the other islands, making altogether a total of fifty-four, two of which are 4100 feet above sea-level. The oldest temperature observations date from the time of the first American mission in 1821, and with some interruptions have been continued to the present time. From the more recent observations the mean annual temperature is 74°·1. During the last ten years the lowest temperature was 54°·0, and the highest 89°·1; the greatest daily variation being 23°. The warmest month is August, mean temperature 78°·1, and the coldest, January, mean 69°·8. Barometric pressure is very regular, the yearly period amounting to about ·07 inch, and the daily period to ·06 inch. The larger oscillations occur only when the almost regular northerly trade winds, which blow on an average for 258 days in the year, are replaced by southerly winds. The rainfall differs considerably in different parts of the islands; at Honolulu the mean of thirteen years' observations is 30·6 inches. The largest amount falls between November and February; the dryest month is June, with about one inch.

August.—"Die neue Anemometer-und Temperatur-Station auf dem Obir-Gipfel," by J. Hann.—On the dynamics of the atmosphere, by M. Möller. This is a continuation of a series of valuable papers on the physics of the atmosphere. The present article deals chiefly with the behaviour of cyclones and anticyclones, and with the vertical distribution of temperature and aqueous vapour.

THE *Botanical Gazette* for August has an article on cell-union in herbaceous grafting, by Mr. John S. Wright, in which the remarkable assertion is made that not only a geranium, but also *Tradescantia zebrina* has been successfully grafted on the tomato, that is, a monocotyledonous on a dicotyledonous plant. Mr. L. N. Johnson describes the mode of formation and escape of the little-known zoospores of *Draparualdia plumosa*.

THE numbers of the *Journal of Botany* for August and September are chiefly occupied by papers on descriptive botany. Mr. H. T. Soppill gives an account of the life-history of *Æcidium leucospermum*, parasitic on *Anemone nemorosa*.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 25.—M. de Lacaze-Duthiers in the chair.—M. Faye, in presenting the *Connaissance des Temps* for 1896, being volume ccxviii., pointed out some improvements newly introduced. The tables of the fundamental stars contain their magnitudes, their mean coordinates at the commencement of the tropical year, their variation and proper motion, and the dates at which the hour stars pass the meridian at noon and midnight.—The geographical coordinates of Tananarivo and the observatory of Ambohidempona (founded at Madagascar by the Rev. Father Colin), by M. Alfred Grandidier.—On the spectroscopic observations made at the Mount Blanc Observatory on September 14 and 15, 1893, by M. J. Janssen (see p. 549). Action of the electric arc upon the diamond, amorphous boron, and crystallised silicium, by M. Henri Moissan.—Preparation and properties of crystallised carbon silicide, by M. Henri Moissan.—On the reproduction of oysters in the Roscoff aquarium, by M. de Lacaze-Duthiers. The ostreicultural work at the Roscoff laboratory was undertaken in order to demonstrate the feasibility of the revival of the oyster fisheries on the French coasts on a scientific basis. During the last two years it has been proved that seed oysters could be brought to a high state of development and commercial value in artificial surroundings. It has also been proved that oysters are capable of reproduction in the aquarium. The culture of oysters is at present divided into two main branches, that of producing seed oysters and that of developing the latter into the article of consumption. The Roscoff laboratory isnow able to perform both functions. The oysters now completing their fourth year of age and their third of culture in the tank, have produced this year about 5000 young oysters, which will be used as seed oysters for future experiments.—M. Bouquet de la Grye, in connection with a recent work by M. Hatt on the harmonic analysis of tidal observations, announced that the Hydrographic Service of the Marine Department intended to adopt the method expounded, viz. that originated by Lord Kelvin, to the calculation of the *Annuaire des Marées*, and that several maregraphical stations are about to be erected in Indo-China, where the tidal phenomena are very singular.—Circles or spheres derived from any envelope, by M. Paul Serret.—On the glucoside of the Iris, by MM. F. Tiemann and G. De Laire. Iris roots contain a glucoside, iridine, which shows some remarkable properties. Alcoholic extract of iris treated with a mixture of acetone and chloroform of density 0·95, gives *iridine*. It crystallises in small white needles, fusing at 208°, and corresponding to the empirical formula $C_{24}H_{36}O_{13}$. Iridine, heated under pressure with sulphuric acid diluted with weak alcohol, decomposes into glucose and a crystalline body now termed *irigenine*. This forms alcoholic ethers, and also gives rise to two series of acid ethers. Under the action of alkaline hydrates, it absorbs three molecules of water, and then splits into three bodies—viz. formic acid, an acid phenol termed *iridic acid*, $C_{10}H_{12}O_5$, and a phenol termed *iretol*, $C_7H_8O_4$. The latter body is rapidly decomposed by the oxygen of the air when in an alkaline solution. When iridic acid is heated above its point of fusion, it splits into 1 molecule of carbonic acid and a colourless oil distilling at 239° by cooling. It solidifies in large crystals fusing at 57°, constituting a well-defined new phenol now termed *iridol*.—Anatomical researches on the grand sympathetic nervous system of the sturgeon, by M. René Chevrel.—Contribution to the histology of the spongidæ, by M. Émile Topsent.—On two new types of the *choniostomatidæ* of the coasts of France, *sphæronella microcephala* and *salenskia tuberosa*, G. and B., by MM. A. Giard and J. Bonnier.

DIARY OF SOCIETIES.

LONDON.

TUESDAY, OCTOBER 10.

PHOTOGRAPHIC SOCIETY, at 8 (at the Gallery, 5a, Pall Mall, East.)

WEDNESDAY, OCTOBER 11.

PHOTOGRAPHIC SOCIETY at 3 and 8 (at the Theatre, Society of Arts, John Street, Adelphi).

THURSDAY, OCTOBER 12.

PHOTOGRAPHIC SOCIETY, at 3 (at the Theatre, Society of Arts, John Street, Adelphi).——At 8 (at the Gallery, 5a, Pall Mall, East).—Special Lantern Night.

FRIDAY, OCTOBER 13.

AMATEUR SCIENTIFIC SOCIETY, at 7.—*Conversazione* and Exhibition.——At 8.—Parasitism, Commensalism, &c.: Mr. Pace.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Inorganic Chemistry for Beginners: Sir H. E. Roscoe and J. Lunt (Macmillan).—Meteorological Observations made at the Adelaide Observatory, &c., during 1884-5 (Adelaide).—Catalogue of the Lepidopterous Superfamily Noctuidæ found in Boreal America: Dr. J. B. Smith (Washington).—Method and Results: T. H. Huxley. (Macmillan) —Practical Work in Heat: W. G. Woolcombe (Oxford, Clarendon Press).—The Process of Argument: A. Sidgwick (Black).—A Dictionary of Birds: A. Newton, &c.; Part 2 (Black).—The Discovery of Australia: A. F. Calvert (Philip).—Personal Recollections of Werner von Siemens: translated by W. C. Coupland (Asher).—In Amazon Land: M. F. Sesselberg (Putnam).—Curiosa Mathematica, Part 2. Pillow Problems: C. L. Dodgson, 2nd edition (Macmillan).—Décoration Céramique au feu de Moufle: M. E. Guenez (Paris, Gauthier-Villars).—Les Moteurs à Gaz et à Pétrole: P. Vermand (Paris, Gauthier-Villars).—Biskra and the Oases and Desert of the Zibans: A. E. Pease (Stanford).—An Essay on Newton's "Principia": W. W. R. Ball (Macmillan).—Catalogue of Section one of the Museum of the Geological Survey of Canada: G. C. Hoffmann (Ottawa).—An Introduction to Human Physiology: Dr. A. D. Waller, 2nd edition (Longmans).—Anatomy, Descriptive and Surgical: H. Gray, edited by T. P. Pick, 13th edition (Longmans).—Analysis of Milk and Milk Products: Dr. H. Leffmann and Dr. W. Beam (Philadelphia, Blakiston).—Eleventh Annual Report of the Fishery Board for Scotland. Part 3: Scientific Investigations (Edinburgh, Neill).—On Hail: Hon. Rollo Russell (Stanford).

PAMPHLETS.—The State of Amazon, Brazil: L. B. Bitancourt.—Fauna and Flora of Norfolk, Part xii. Coleoptera: J. Edwards.—Zur Kenntniss der Postembryonalen Schädelmetamorphosen bei Wiederkauern: H. G. Stehlin (Basel, Schwabe).—Latitudine di Torino determinata coi Metodi di Guglielmo Struve: F. Porro (Torino, Clausen).—Effemeridi del Sole e Della Luna, &c.: A. Manaira (Torino, Clausen).—Osservazioni Meteorologiche fatte nell'anno 1892, All Osservatorio della R. Universita di Torino: Dr. G. B. Rizzo (Torino, Clausen).—Catalogue of Woods Exhibited by the State of Amazon, Brazil, at the World's Columbian Exposition, Chicago (Chicago).—The City of Manáos and the Country of Rubber Tree (Chicago).

SERIALS.—Zeitschrift für Wissenschaftliche Zoologie, lvi. Band, 3 Heft (Williams and Norgate).—Bulletin de l'Académie des Sciences de Belgique, No. 8, Tome 26 (Bruxelles).—The Free Review, October (Sonnenschein).—Michigan Agricultural Experiment Station Bulletins, 96 to 99 (Michigan).—Zeitschrift für Physikalische Chemie, xii. Band, 3 Heft (Leipzig, Engelmann).—Journal de Physique, September (Paris).—Natural Science, October (Macmillan).—Journal of the Institute of Jamaica, August (Kingston, Jamaica) —Botanical Gazette, September (Bloomington, Ind.).—Medical Magazine, October (Southwood) —Agricultural Gazette of N.S.W., July (Sydney).—Journal of the Royal Agricultural Society of England, third series, vol. 4, Part 3, No. 15 (Murray).—India Weather Review, Annual Summary, 1892: J. Eliot (Calcutta).—Geological Magazine, October (K. Paul) —Geographical Journal, October (Stanford).

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